THURSDAY, JANUARY 30, 1890.

THE HYDERABAD CHLOROFORM COMMISSION.

THE safety of anæsthetics is a subject of the deepest personal interest to everyone, either on his own account or on that of his family or friends. For this reason, the general public, as well as the medical profession, have been looking with interest for the Report of the Chloroform Commission which has lately been trying to work out the subject under the generous auspices of the Nizam and his Minister Sir Asman Jah. As we pointed out in NATURE of December 19, 1889, p. 154, two views regarding chloroform are commonly held. The one view is that it may kill by paralyzing the heart directly. The other is that it really kills by paralyzing the respiration, and only stops the heart indirectly through the asphyxia which quickly follows stoppage of the respiration. The first view is generally held in London, the second in Edinburgh, where it was strongly insisted on by the late distinguished surgeon Prof. Syme. As we learn from the Report now published, it was in consequence of his reverence for Syme's teaching, that Surgeon-Major Lawrie moved for the appointment of the Commission, which was generously granted by the Nizam's Government. This teaching was founded on clinical experience, but the results of some physiological experiments appeared to show that it was incorrect, and that chloroform paralyzed the heart directly. To ensure anything like general acceptance of Syme's teaching it was necessary that it should be shown that these experiments did not really disprove it. But this necessitated a complete revision of the whole question of the *modus operandi* of chloroform, and of the production of an immense amount of experimental evidence. This has been supplied by the present Commission, and the result of their labours appears to be that there is some truth in both views, but that when chloroform is given in the ordinary way by inhalation, it is the respiration which stops first. When chloroform vapour is blown down the trachea the heart may be stopped by it, but when the vapour is drawn into the lungs in the usual way by the movements of the chest, this is not the case, for, the respiratory movements being arrested first, their stoppage prevents any more chloroform vapour from being taken into the lungs. Embarrassment of respiration constitutes the first sign of danger, and should be at once attended to. The breathing should not be allowed to stop, but if it should do so by any accident, life may still be preserved by the immediate use of artificial respiration. Should the interval of asphyxia between the stoppage of natural breathing and the commencement of artificial respiration be too long, the heart may fail to such an extent that artificial respiration is in vain; and if the administrator waits for a failing pulse to warn him of danger, the warning may come too late. In a former research by the Glasgow Committee of the British Medical Association, some of the experiments, in the opinion of the Committee, seemed to show that chloroform not only lowers the blood-pressure and paralyzes the heart, but does so sometimes in an unexpected and capricious manner. The Commission has repeated their experiments, and found a similar fall of the blood-pressure and slowing of the pulse, but has come to a different conclusion regarding their causation, and attributes them not to chloroform but to asphyxia. If this opinion be correct, it shows how much care is necessary to avoid asphyxia, for the Glasgow Committee appear to have overlooked its presence, notwithstanding the serious effects it was producing on the heart in the animals on which they were experimenting. The work of the Hyderabad Commission points strongly to the conclusion that deaths from chloroform in man are likewise due to asphyxia, and the Commission considers that by careful attention to the respiration all deaths may and should be prevented. The Report points out that instead of the conclusions at which the Commission has arrived being opposed to those of Claude Bernard, they are almost exactly those at which that distinguished physiologist, so well known for his accurate work, had arrived, although his name is often quoted in support of the doctrine that chloroform kills by paralyzing the heart. The number of experiments on which the Commission bases its conclusions is very large, no fewer than 430 having been done without recording apparatus, and 157 with recording apparatus. The former consisted chiefly of experiments, firstly, on the general action of chloroform given in various ways, in various dilutions, and in different conditions of the animal, *e.g.* fasting, after meals, after a preliminary dose of spirits, &c.; and, secondly, on the limits within which artificial respiration could restore life, and the effect of morphine, strychnine, atropine, &c., in modifying the action of the anæsthetic and the reviving power of artificial respiration. The necessary apparatus was taken out by Dr. Lauder Brunton, and on his arrival at Hyderabad the Commission was at once constituted: Surgeon-Major Lawrie, President; Drs. Lauder Brunton, Bomford, and Rustamji, members; Dr. Bomford acting as secretary. They were greatly aided in their work by the members of the first Commission, Drs. Hehir, Kelly, and Chamarette, as well as to Messrs. Tripp, Carroll, and Mayberry, the latter of whom gave the chloroform. To Dr. Chamarette's energy and fertility of resource the success of the experiments was mainly due. The work was continued daily from 7 a.m. to 5 p.m., except on Sundays and holidays, from October 23 to December 18. From a speech made by Dr. Lauder Brunton at a dinner given to the Chloroform Commission by the Nawab Intesar Jung, we learn that the facilities for work afforded to the Commission were such as were not to be found even in the great laboratories of the continent of Europe; and, indeed, the large number of experiments which were made in a comparatively short time, is sufficient of itself to show this. At this dinner the Nawab Intesar Jung reminded his guests that Europe is indebted to Mohammedan writers of the schools of Bagdad and Cordova for the preservation of medical science during the dark ages; and as Dr. Lauder Brunton very truly said in his reply, the Nizam has not only followed the traditions of the Mussulmans in selecting the subject of research, but has rivalled the generosity of Haroun-al-Raschid and Abdurrahman in supplying the Commission with every-

thing it could require. Although the liberal endowment of universities and schools is now fortunately much more common, especially in America, than it used to be, yet there are few instances of such liberality as the Nizam has shown towards definite subjects of scientific research. For the excellent example they have shown in this matter, the Nizam and his enlightened Minister, Sir Asman Jah, deserve the thanks of the scientific world, while they also deserve that of the public in general for their endeavour to save life and lessen suffering by rendering the administration of anæsthetics so safe that they may be employed without fear whenever they are required.

HYGIENE.

Hygiene, or Public Health. By Louis C. Parkes, M.D. (London: H. K. Lewis, 1889.)

DR. LOUIS PARKES has conferred an important service by the opportune publication of his manual of hygiene. The public mind has been slow to perceive the importance of the science of preventive medicine. For nearly half a century Sir Edwin Chadwick and others have preached the doctrine. It fell for a long time on sterile ears. No doubt provisions have been made by Parliament from time to time, when some special danger or disease-cause was brought prominently into notice: not, indeed, as a part of a system of sanitary protection, but as if it were the only matter to be cared for. Thus, vaccination was made compulsory to stop small-pox, but for a long time many other diseases were ignored. These scattered efforts in sanitary legislation were brought to a focus in 1875, and systematic sanitation may be said to have been instituted by the division of the country into sanitary areas, and by the appointment of medical officers of health. These provisions were rather a theoretical recognition of the importance of the subject than a practical creation of efficiency, for the medical officers in a large number of instances have not received such remuneration as would enable them to give their whole time to their duties; nor do they possess security of tenure. They have been, for the most part, men in local practice, who have been content to receive an honorarium in some cases as low as £20 or £10, and occasionally even £5 and £3 a year. Such payments could not be expected to induce men to do more than give a nominal service to their official duties; and it is, indeed, notorious that in many instances the object of members of the sanitary authority which has made the appointment, who are themselves owners of house property, has been to nominate men who would let matters rest, and would not compel owners of cottages to spend money on sanitation.

We are now, however, entering upon a new era in sanitation. The creation of County Councils which took place last year has introduced a new feature. Although the powers vested in these bodies are permissive and somewhat tentative, it has already become quite certain that they will, sooner or later, bring the whole sanitary service of the country under their general supervision and control.

The Local Government Act of 1888 lays down the provision that the medical officer of health to be appointed by a county must be qualified in sanitary knowledge—that is to say, in the knowledge of the prevention of disease, as distinguished from curative knowledge. It will, therefore, be necessary that the men appointed shall have spent time and money in obtaining the required qualifications for their duties: hence they will expect adequate salaries to remunerate them for the trouble and expense which they will have incurred in thus educating themselves. The call for education in preventive medicine will react upon the medical schools and the various degree-conferring bodies—such as the Universities—and will compel them to hold examinations in, and to confer diplomas or certificates upon the possessors of, sanitary knowledge. Moreover, the sanitary authorities, in order to justify to themselves the higher salaries which they will be compelled to pay, will be induced to place enlarged areas under the medical officer, and, in order that he may effectually perform his duties, he will insist on being furnished with a better educated staff of sanitary inspectors or inspectors of nuisances than have been, as a rule, appointed under the old *régime*.

It is thus evident that there will soon be a great call for sanitary education, and Dr. Parkes's volume forms a very useful commentary upon what are the general heads comprised in a course of instruction in the methods necessary for applying various branches of science to the prevention of disease. A glance at the table of contents shows the very large field embraced under the title of preventive medicine. It concerns not only the medical man, but the engineer, the architect, the chemist, the physiologist, the meteorologist, and the statistician. The questions to be studied include climatic conditions; the effect on health of the state and movement of the atmosphere; the health of soils; the purity of water-supply, and the prevention of injury to health from fouled water; the construction of buildings, their warming, lighting, and ventilation; questions of food and clothing; the history of communicable diseases; and bacteriology, as well as hygienic chemistry and statistics.

A brief summary of the present position of our knowledge shows us that preventive medicine is still far removed from being an exact science. We have, no doubt, lately made much progress in removing from the medical man the imputation that his proceedings were empirical. Physiological studies in recent years have established the relationship between certain diseases and the presence of micro-organisms; and although this relationship may not be as universal as some persons would hold, yet we know that there is a positive relationship in the case of certain diseases. When the causes of diseases are known; when the action of the causes can be studied, and their mode of entrance into the body ascertained; when the methods which can be applied to their destruction are discovered; then the science of the prevention of disease ceases to be empirical.

Whilst, however, our progress in this knowledge has of late years been extremely rapid as compared with former experience; yet when, as in this volume, we are brought face to face with the various problems of the prevention of disease, we are amazed to find what a vast field is still unexplored in the knowledge of the causes of disease. Dr. Parkes has given a very interesting summary of our knowledge on this part of the question in his chapters on

contagia and communicable diseases. We may be said at present to be only standing on the threshold of this very intricate subject. Even in the case of those diseases which have been ascribed with the greatest assurance to the presence of organisms in the blood or the tissues, we are told that it is as yet uncertain whether the symptoms of disease are the results of the direct action of microbes themselves upon the tissues, or are caused by their indirect action in producing poisonous alkaloids or ferments. We have not yet elucidated the curious connection between the diseases of animals and mankind; but whilst we are gradually acquiring the conviction that some diseases from which animals suffer are communicable to the human race, it is at any rate satisfactory at the same time to have arrived at the certainty that those laws of cleanliness in air, soil, and water, which are the basis of human sanitation, are the most effective safeguards to be observed in the case of domestic animals, if certain classes of disease are to be avoided. But with all our increased knowledge of the existence and methods of propagation of the various forms of organisms which appear to co-exist with certain forms of disease, we have not yet discovered why certain diseases become epidemic at certain times, whilst they lie comparatively dormant at other times; Nature has not yet revealed all her secrets to the microscope or to the laboratory.

Take as an instance, the influenza which is now present with us. Its epidemics are historical. It has appeared over and over again at somewhat distant intervals. But we do not know why it comes at one time and not at another. It has been specially described on various occasions since 1557. In 1837 it covered the whole of the north of Europe in fifteen days. It travels as rapidly through sparsely inhabited as through populous countries. In 1780 it manifested itself in ships in mid-ocean, which had had no communication with the shore. The facts connected with its incidence are thus well known. Its progress would scarcely seem to be accounted for by contagion or infection in the common acceptance of the word. Is its present advent due, like the beautiful sunsets with which we were favoured a few years ago, as some observer suggests, to a catastrophe in some distant part of the globe? or is it owing, as M. Descroix, of the Meteorological Observatory at Montsouris, tells us, to the remarkably stagnant atmosphere of last autumn? Large populations agglomerated in towns depend, for the removal of the foul emanations continually passing into the atmosphere from their midst, upon the action of winds and storms, and these causes of ventilation were notably absent during the past autumn; and Dr. Descroix points out that the failure to remove this impurity would favour the propagation of organisms injurious to the health of the community, acting in this respect just as a festering drain or manure heap would act.

The advance which each separate science makes opens out new views to the hygienist, and this short reference to the epidemic of influenza serves to point out the extent of the subject, and to impress upon us the fact that it is almost impossible that a moderate-sized treatise by a single individual could form an adequate text-book for the student in these various and intricate questions.

Dr. Parkes's volume, admirable as it is in many respects, leaves something to be desired in its treatment of some of the subjects. We would especially refer to those relating to civil engineering and architecture, which are not the special subjects of a medical man. The treatment of these branches presents some weak points, and there is an occasional tendency to recommend specific inventions rather than to enunciate principles, which may somewhat militate against the general acceptance of the volume as a complete and permanent text-book.

It would have been better if the educational features of the book had been limited to those special subjects with which the profession of the author has made him most familiar. The work is, however, a convenient hand-book, and will serve as a valuable guide to show the student what are the several subjects which have to be studied; and in that sense we can safely recommend it as an adjunct to the library of every sanitarian.

IN THE HIGH ALPS.

Im Hochgebirge. Wanderungen von Dr. Emil Zsigmondy. Mit Abbildungen von E. T. Compton. Herausgegeben von K. Schulz. (Leipzig: Duncker and Humblot, 1889.)

THIS handsome volume possesses a melancholy interest, for it is in reality a memorial to a young and ardent mountaineer who was killed by a fall from a precipice in the year 1885. Emil Zsigmondy was by descent a Hungarian, but was born and educated in Vienna, where his father practised as a physician. The son followed the same profession, of which he was a distinguished student. As a boy he showed a love of mountain-climbing. At the age of fifteen, he and his brother Otto, without guides, made an ascent of the Reiseck, a peak 2958 metres high. The expedition occupied twenty-six hours, of which twenty-two were spent in actual walking, a remarkable feat of endurance on the part of two lads.

After this Emil made annually an Alpine excursion, the expeditions increasing in difficulty and (with the exception of one year) in number. The first of which a description was published was accomplished in his eighteenth year, and after this references to the journals of foreign Alpine Clubs and similar publications are frequent on the list. Altogether, as we are told in the brief biographical notice prefixed to this work, Emil Zsigmondy, though he perished a few days before completing his twenty-fourth year, had climbed nearly 100 summits of more than 3000 metres in height above the sea—in more than nine cases out of ten unaccompanied by guides. Most of the expeditions described in this volume have already appeared in various journals, and describe excursions which in themselves are not new; but many of them have this special interest, that they were made without guides. Sometimes the brothers were alone, but on the more difficult excursions they were generally accompanied by one or two trusty friends, such as Prof. Schulz, editor and part-author of this work.

The book is a record of Alpine expeditions told in plain but graphic language. It scarcely touches upon scientific questions, though we are informed that Emil was a student of Alpine botany, zoology, and geology, and published some observations on these subjects in a work which

appeared before his death. But now and then a chance remark indicates the geologist, and there is an interesting account of a remarkable appearance of the "Brocken spectre." This was witnessed from a rocky ridge near the summit of the Bietschhorn, a lofty peak on the southern side of the Bernese Oberland. The shadow of the observer was seen within a triple rainbow-ring. Of these rings, the inner one exhibited the usual tints; these were weaker in the second, and barely visible in the third. The shadow was larger than life, but was less than the diameter of the inner ring. By this, according to the text, it was encircled; but in the accompanying woodcut the shadow of the legs from below the knees is thrown upon the rings. The sun was getting low, and towards the west, for it was nearly 4 o'clock on an afternoon early in September. The wind came from the same direction, and the clouds were drifting eastwards from the mountain-peak. The "spectre" remained visible for nearly an hour, while the observers completed the ascent to the actual summit.

The illustrations are numerous, and some of them are not without a scientific value as faithful renderings of mountain scenery. It is seldom that the same can be said of similar engravings in English books. These, if no longer the caricatures which were formerly supposed to represent mountains, are still too often devoid of character. Mr. Whymper can and does give the outline of a mountain peak and the distinctive features of its rocks, but the ordinary illustrator is content with some conventional smudging which serves impartially for granite or limestone, for schist or slate, and is equally unlike each one of them, or, indeed, anything that exists on this earth. But as our artists are at length beginning to realize that Nature's workmanship is better than their own, and to follow the path which was trodden by Turner, Elijah Walton, Ruskin, and a few pioneers, we may hope that the illustrations of mountain scenery in English books may rise to the level of Continental publications, which, though not free from mannerisms, do make some attempt at accuracy. Those in the present work consist of eighteen full-page photogravures, copied apparently from water-colour drawings, and of a large number of woodcuts, which are in part from finished drawings, in part from pen-and-ink outline sketches. Many of the former are excellent, so also are some of the latter; but these are less successful in representing scenery than in recording little incidents in the mountaineers' experience. The simple unaffected narrative of adventure, in which there is evidence of skill in dealing with mountain difficulties, and courage, pushed, perhaps, sometimes to the border of rashness, is very pleasant to read, and it is sad to think that such a life has been lost to his many friends. The fatal fall occurred during an attempted ascent of the Meije, in Dauphiné, by a new route up the southern cliffs. Emil had climbed some distance above his two companions, when he fell from a cliff. They bravely attempted to check his descent by means of the rope which was attached to his waist, but it snapped under the strain, and the climber in a few moments lay lifeless on a glacier 2000 feet below. A full account of the accident was published in the *Alpine Journal* for 1885, which indicates that on this occasion more risk was being incurred than could be justified. T. G. B.

THE STORY OF CHEMISTRY.

The Story of Chemistry. By Harold Picton, B.Sc., With a Preface by Sir Henry Roscoe, M.P., D.C.L. LL.D., F.R.S. Pp. 386. (London: Isbister, 1889.)

IT is a matter for surprise that, among the many books on the different branches of chemistry, so few are to be found devoted to the historical treatment of the science. The ordinary student in attempting to get an idea of the development of the subject labours under considerable disadvantages. From time to time, indeed, our professors are to be heard expounding "The Atomic Theory," "Joseph Priestley," "The Birth of Chemistry," and like topics; books on such subjects also exist. Our larger treatises, as a rule, have short historical introductions; text-books, too, occasionally contain information such as "the gas discovered by Rutherford in 1772 was subsequently named nitrogen by Chaptal." From such sources, however, a conception of the fundamental discoveries which have led up to the chemistry of to-day is only possible by dint of much searching, and at an expenditure of time far beyond that at the disposal of most students. A short history of the science in a handy form would be a decided acquisition to chemical literature. The name of the little volume before us is thus a promising one, and on perusal, the book in no way belies its title.

After showing who the alchemists were, and the state of chemical knowledge before they appeared on the scene, the author proceeds to divide his subject into nine periods. The first of these, "Alchemical Mysticism," extending from the time of the mysterious Hermes Trismegistus to that of Roger Bacon and Raymond Lully, includes also an account of Geber and Albertus Magnus. Next comes "Medical Mysticism," in which are sketches of Basil Valentine and his "Triumphant Chariot of Antimony," of Paracelsus and Van Helmont: followed by the "Decline of Mysticism," reaching down to the founding of the Royal Society of London by Charles II. in 1662, and embracing the work of Glauber and Helvetius. The fourth period, "The Beginnings of Science," deals with Boyle, Hooke, Mayow, and Hales. The reader's attention is then directed to Black's introduction of "weighing" as a means of investigation. This chapter, which gives, besides, a pretty picture of Cullen, Black's instructor, constitutes the "Childhood of Truth." Then follows, under the heading of "The Conflict with Error," a succinct account of the rise and progress of Stahl's phlogiston theory, with its bearings on the researches of Priestley, Cavendish, Scheele, and their contemporaries. Lavoisier's keen penetration and masterly deductions, "The Triumph of Truth," are then discussed, and lead up to "The Atomic Theory," Dalton's idea, and its later developments, from the time of Gay-Lussac, Ampère, and Avogadro, to that of Newlands and Mendeléeff. After a separate chapter on Davy and Faraday the book is brought to a close by short descriptions of the present state of inorganic and organic chemistry.

Mr. Picton's style is fresh and pleasing; his descriptions are clear and to the point. Whenever possible, brief surveys of the life and work of the men of science mentioned are given. Extracts from original writings are frequently quoted, and pains taken to enable the reader to form an idea of the general character of the individuals apart from their chemical discoveries alone. Chronological

order has not in every case been adhered to, the main idea and its subsequent development being frequently treated together; but the sequence of epoch-making events is strictly maintained. The work is quite up to date; when advisable, the author has introduced facts which have only been established by recent investigations.

The book is tastefully bound, and the illustrations are numerous. The latter are varied, and embrace cuts from "Die Zwölf Schlüssel," apparatus historic and modern, and portraits of celebrated chemists. To the reader possessed of some chemical knowledge the volume will be most useful, and to the uninitiated its earlier chapters, at least, cannot fail to be inviting.

LUMINOUS ORGANISMS.

Les Animaux et les Végétaux Lumineux. Par Henri Gadeau de Kerville. (Paris: J. B. Baillière et fils, 1890.)

THIS little book is a semi-popular summary of what is known in regard to the photogenous structures of the various kinds of luminous animals and plants, commonly (but improperly, as the author points out) known as phosphorescent. As it is on the whole fairly complete and accurate, being based largely upon the important researches of Panceri, Sars, R. Dubois, Emery, and others, it will probably be useful not only to amateurs, but also to students who wish to get a general knowledge of the range in organic nature of light-producing forms, and of the more important investigations on the subject which have been made since the days of Aristotle and Pliny.

Although the title-page of this book bears the date 1890, the important discovery by Giard, in September last, of luminosity in Amphipods which is due to an infectious disease is, it may be supposed, too recent to have been included—at any rate, it is not referred to.

After a short historical *résumé*, the first half of the work (170 pages) is occupied by a systematic account of those plants and animals which are luminous, commencing with the plants and then working up through the animal series from Protozoa to Vertebrata. More animals than plants are photogenous, and most of these are marine. Few observations have been made upon freshwater forms, and none are known from brackish water. M. Gadeau de Kerville takes care to point out, what is undoubtedly the case, that many supposed instances of luminosity, especially in dead animals or in the neighbourhood of harbours, &c., where there is much decaying organic matter, are due, not to any "phosphorescence" of the animal observed glowing, but to the presence of luminous Bacteria on the surface, in mucus, or in the tissues. Several species of light-producing micro-organisms (*Bacilli* and *Micrococci*) are already known, and the list will probably be largely added to in the future. It is, however, an excess of caution to doubt the claim of *Ceratium* (*Peridinium*) to be placed amongst photogenous genera, as two or three of the species appear to be responsible for a good deal of the "phosphorescence of the sea" around our western coasts in autumn—a phenomenon which is usually attributed even by naturalists to *Noctiluca miliaris*, although at such times it often happens that not a single *Noctiluca* is caught by the townet!

The well-known observations and experiments of Panceri on *Pennatula* and other forms are given, and the figures reproduced, and it will no doubt be useful to many to have the information obtained by various investigators thus collected into one volume. On p. 83 is given an observation by Quatrefages upon certain luminous *Talitri* (Amphipod Crustaceans) on the beach, which he supposed had derived their luminosity from contact with *Noctiluca*. Is it not more probable that, like Giard's diseased Amphipods at Wimereux (which, by the way, have turned up lately at Jersey, and will probably be found to be widely spread), they were infested by a photogenous microbe?

In connection with the remarkable "luminous globules" of some Schizopods (*Euphausia*, *Nyctiphanes*, &c.), M. Gadeau de Kerville suggests that these organs are light-perceiving, as well as light-producing, and that, therefore, the old designation of "accessory eyes" was not improperly applied. This view is supported by several observed cases where the true eyes of higher Crustacea were luminous; but it should be remembered that it is entirely opposed to the matured opinion given by G. O Sars in his Report on the *Challenger* Schizopods.

Chapter xiii. is devoted to an account of the anatomy and physiology of the photogenous organs, in which, however, little of importance is added to what was given in the preceding part of the book. The author adopts the view of Dubois (founded upon experiments on *Pholas dactylus* made at the Roscoff Laboratory), that in all cases the luminosity is a purely physico-chemical phenomenon, and is dependent on the presence of two substances—the one (*luciférine*) soluble in water and obtainable in the crystalline state, the other (*luciférase*) a soluble ferment (like diastase)—which must be brought in contact in order that light may be produced. This seems going further than our present knowledge really warrants. The light-producing organisms and organs are so varied that it is possible that the causes of the luminosity may be manifold; and, at any rate in the higher forms, the bringing together of the *luciférine* and *luciférase* must be under the direct control of the nervous system, as the production of light is a reflex, perhaps in some cases a voluntary, action.

In a short chapter, entitled "Philosophie naturelle," the author considers, from the evolution stand-point, such questions as the origin of luminosity, the reason why only relatively small numbers of animals and plants are luminous, why the majority of luminous animals are marine, &c.; but for a discussion of these points, and also of the various uses (both to animals and to man) which the luminosity may have, reference must be made to the book itself, which, although some of the illustrations are poor, and there is unnecessary repetition and verbosity in the text, forms a readable and useful introduction to a very interesting and important subject.

W. A. HERDMAN.

OUR BOOK SHELF.

The Chemistry of Photography. By R. Meldola, F.R.S. (London: Macmillan and Co., 1889.)

THIS work is well worthy of study by serious devotees of photography. It enters, as its title indicates, into the chemistry of photography, and that in a very thorough and

easily understandable manner. There are some very few points in the author's explanations of phenomena as regards which we cannot quite agree with him. For instance, when he is considering the action of light on silver chloride he states that an oxychloride is formed (on the authority of Dr. Hodgkinson). That this is not always the case is shown by the fact that silver chloride is darkened when exposed in the presence of bodies which contain no oxygen, as, for instance, when the exposure is given in benzene. The author has adopted the plan of calling his chapters lectures, and in this instance we shall find no fault with what often is an artifice to cover slipshod writing, since the subject-matter is good, the language clear, and descriptive experiments are appended after each note in the narrative. We feel assured that if a student be fairly grounded in elementary chemistry and carries out these experiments, he will have a far better knowledge of the theory of photography than nine out of ten students possessed before this work was written. The author rightly points out that much in the theory of photography still requires elucidation, and with this we quite agree; but by putting into a connected shape those portions of the theory which may not require reconsideration, he has done much towards facilitating the solution of the remaining problems which are still *sub judice*.

The Popular Works of Johann Gottlieb Fichte. Translated from the German by William Smith, LL.D. With a Memoir of the Author. Fourth Edition. In Two Vols. (London: Trübner and Co., 1889.)

THESE volumes form part of the well-known "English and Foreign Philosophical Library." The translations included in them were first published in 1845-49, when German philosophy had only begun to attract attention in England. Fichte holds so clearly marked a place in the development of modern thought that it is still worth the while of students to make themselves familiar with his governing ideas; and there can be no disadvantage in their beginning with his popular rather than with his more systematic works. So far as the form of Fichte's teaching is concerned, it cannot of course be said to meet the needs of the present day. To many minds there is something even irritating in his use of large, abstract expressions, which are incapable of precise definition, and in the dogmatic tone in which he proclaims his convictions, as if he had somehow had special access to the sources of absolute truth. But his effort to solve the questions which lie behind the problems of physical science has at least the interest that belongs to perfect sincerity; and his methods and conclusions, whether they commend themselves to our judgment or not, are often in a high degree suggestive. He was personally of so manly and noble a character that his popular writings, in which he expressed his sympathies and tendencies freely, are perhaps more valuable from the ethical than from the strictly intellectual point of view. Dr. Smith's work as a translator is, we need scarcely say, excellent; and the like may be said of his work as a biographer. His memoir of the philosopher is written in a thoroughly appreciative spirit, and with adequate knowledge.

Travels in France. By Arthur Young. With an Introduction, Biographical Sketch, and Notes, by M. Betham-Edwards. (London: George Bell and Sons, 1889.)

EVERYONE who has given even slight attention to the pre-revolutionary period of French history knows, at least by hearsay, something about Arthur Young's "Travels in France." No other work of that time throws so clear and steady a light on the social and economic conditions which prevailed among the mass of the French people immediately before their great national convulsion. This is well understood by French historical students, who have found in the record of Young's observations a mine of information on the very subjects about which they are most anxious to obtain trustworthy contemporary statements. The present reprint deserves, therefore, to be cordially welcomed. It has been carefully edited by Miss Betham-Edwards, who, in an interesting introduction, prepares the way for the study of the book by presenting "a contrasted picture of France under the *ancien régime* and under the third Republic." She also gives a valuable biographical sketch of Arthur Young, the materials having been supplied by his grandson.

LETTERS TO THE EDITOR.

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Acquired Characters and Congenital Variation.

MR. DYER accuses me of invading the pages of NATURE by methods of discussion characteristic of the political debater. Those methods, however, may be good as well as bad. In addition to direct affirmative arguments in support of a particular conclusion, they may trace the working and the power of preconceptions which in science, as well as in other things, are an abounding source of error. On the other hand, methods of debate may be confused and declamatory, dealing in vague phrases, and delighting in clap-trap illustrations. If I could not handle a scientific question by some method less adapted to the "shilling gallery" than the method of my censor in this case, I should wish to be silent for evermore. In his letter I see "Teleology" compared to "a wise damsel" who is "temporarily ruffled," but who nevertheless "gathers up her skirts with dignity." I see Addison brought in, head and shoulders, with "the vision of Mirza." I see Fortuity described as "inseparable from life," with the somewhat obscure oratorical addition that "it is at the bottom one of the most pathetic things about it." I see mixed metaphors of all sorts and kinds, "the church," and "orthodoxy," and "automatically self-regulating machines," and "tenacity about outworks"—and many other such words and phrases—all handled according to methods which do not strike me as at all perfect examples of true scientific reasoning.

Nor am I able to follow Mr. Dyer's logic better than I can admire his declamation. The object of my last letter, which he attacks, was to lay down and defend the proposition that "there is no necessary antagonism between congenital variation and the transmission of acquired characters." Mr. Dyer admits this proposition to be "perfectly reasonable," adding, in respect to this supposed antagonism, "theoretically there is none." But then he proceeds to say, "this does not make the transmission of acquired characters less doubtful." In other words, the complete and effectual removal of an adverse presumption is of no value in an argument which rests altogether on difficulties and doubts. This would be unreasonable enough considered merely in the abstract. But it becomes still more unreasonable when we recollect that the whole doctrine of evolution implies, of necessity, the continual rise of new characters and the transmission of them. These new characters are "acquired" in one sense, and they may be congenital in another. They not only may be, but probably they must be, acquired from latent congenital tendencies, and they may be fixed and transmitted only by those tendencies ceasing to be latent. On this view of the matter, the present controversy between the two conceptions becomes a mere logomachy. The different breeds of dog do undoubtedly transmit characters which have been "acquired." But it is always possible to assert, and always impossible to deny, that these characters arose out of congenital tendencies latent in the species. Mr. Dyer's assertion that this method of reconciling the two ideas "does not make the transmission of acquired characters less doubtful," is an assertion, therefore, which is obviously wrong. The reconciliation attacks the difficulty about the "inheritance of acquired characters" at its very heart and centre. It shows it to lie—as a thousand other difficulties have lain before—in an ambiguous word. "Acquired"? Yes; but from what? From "use"? Yes, but whence came the possibility

of "use"—and the tendency—or the disposition—or the instinct—to use? The answer may be, and perhaps always must be, that the possibility of each new use, and the disposition to it, has been acquired from the evolution of elements inherent in the germ.

The next specimen of pure scientific reasoning which I find in Mr. Dyer's letter is involved in his rebuke to me for having made an assertion in support of which I have produced no "definite observed evidence." That assertion he correctly quotes thus:—"All organs do actually pass through rudimentary stages in which actual use is impossible." He challenges me for proof. I return the challenge, and summon Mr. Dyer to produce one single instance of any animal which does NOT pass through such stages. It is the universal law of all organic beings. In some germ—in some bud—in some egg—in some womb, every living thing begins to grow. Moreover, what is true of it as a whole, is true of all its parts. All its organs—be they few and simple, or many and complex—pass through stages of incipience, of impotence—of divorce from even the possibility of actual and present use. It is truly an astonishing circumstance that any scientific man should ask for any proof of this. It is a signal illustration of the power of neglected elements in reasoning—of the familiar becoming the practically unknown, because it is the unconsidered.

Possibly, Mr. Dyer may say that he did not understand me to make the assertion of each individual organism. But this is a distinction without a difference. If the Darwinian theory be true, there has never been any other origin for species than the origin of a few first germs—developed ever since by the processes of ordinary generation, through a succession of individuals. The well-known generalization of Darwinian embryologists is that the fœtal development of the individual organism is the type and repetition of the development of species in the womb of time. In the doctrine of "prophetic germs," which he quotes as mine, nothing is mine except, perhaps, the adoption of the words. It is the embodiment, in what I hold to be accurate and appropriate language, of the most familiar facts in nature, and of the intellectual conceptions which are their necessary counterpart in mind.

There is one consequence necessarily following from this conception, which is seldom thought of and never fully accepted or recognized; and that is, that, if every organism has been developed from older organisms by very slow and gradual and minute changes through unnumbered ages, there must have been a constant succession of new organs coming on, along with an equally constant succession of other organs passing off. I see no escape from this conclusion. Yet if it be true, nothing can be more unreasonable than to wonder at the occurrence of structures which are divorced from actual use, and which are variously called "rudimentary," or "aborted." The common interpretation always is that they are the inherited remains of structures which have been once in full use, and have been lost by the atrophy of disuse. This may or may not be true, according to special facts in each case. But that there has always been in time past a series of incipient structures on the rise for actual use in future generations of development is a necessary consequence of the Darwinian hypothesis, and indeed of all other forms of pure evolutionism. The only escape from it is the supposition that special organs may have arisen suddenly—may have advanced rapidly into functional use—as rapidly as a caterpillar rushes into the structure of a butterfly, after a short interval of inactivity or sleep.

This is possible—this is at least conceivable. Nay more, this may have been the process by which new species have been introduced. But this is not Darwinism. The occasional introduction of new germs, with new potentialities, and the "hurrying up" of these through rapid stages of development, or of hatching, is an idea which, if I remember right, did not escape the speculative glance of Darwin. But it was too incongruous to be easily assimilated with his special formulæ, and so his fine eye glanced off it again, after only a momentary look; and at a later date he was so biassed in favour of the mechanics of fortuitous variation that he came to regard the very idea of development being guided towards any use yet lying wholly in the future as incompatible with his theory, and indeed destructive of it.

Mr. Dyer says that there was nothing in my last letter "which has not been worn threadbare by discussion." If so, it seems a pity that Mr. Dyer should have interposed in a discussion which he thinks exhausted. This impression may account for the poverty of the contribution made by an able man to a subject which is perhaps the most difficult, the most interesting, and the most far-reaching which can engage the human understanding.

ARGYLL.

Inveraray, January 19.

Multiple Resonance obtained with Hertz's Vibrators.

WHILE Mr. Trouton and I were carrying out some experiments to try and drive an independent current through the arc formed when a spark passes in a Hertzian resonating receiver, we succeeded to some extent in doing so, but obtained an unexpected result which may be of service to others working upon this matter. We found that if the two sides of the receiver be connected with a delicate galvanometer, it is affected whenever a spark passes. It is not so easy to get sparks to pass when the galvanometer is so connected as when the receiver is insulated; but whenever a spark passes, the galvanometer—a 7000-ohm Cambridge Scientific Instrument Company's pattern—is deflected through several degrees and often off the scale. It is not very easy to see how the action takes place, because one would imagine that an electro-dynamometer would be required. The current is reversed along with the reversal of the primary induction, and seems to be connected with the direction of the electromagnetic impulse that first breaks down the air-space in the receiver: an explanation founded upon this consideration explains the facts so far, but further investigation is required to fully confirm it. We have found this method of observing the Hertzian phenomena, which we have worked successfully with an apparatus giving a wave-length of 0·6 metre, much more satisfactory than the method founded on utilizing the conductivity of the spark as a path to drive an independent current either across or along. Some experiments in a vacuum tube, however, showed that this method is capable of extension. We found it also more satisfactory than a bolometer method, which, however, worked fairly well. For this we interposed, instead of the spark-gap, a very fine wire, which was made into one of the arms of a Wheatstone's bridge. The great desideratum was a *very* fine wire, and we intend trying silvered quartz fibres if we can obtain them, and lead drawn inside glass, &c., our hearts having been broken trying to use that brittle beauty, Wollaston wire.

Any of these methods, in which your observing apparatus, the galvanometer, can be at a distance from the receiver, is more manageable than ones like that described by Mr. Gregory, in which the receiver is itself also the observing apparatus. We exhibited our method of observing the occurrence of spark by connecting the ends of the spark-gap with a delicate galvanometer at the meeting of the Dublin University Experimental Science Association last November.

GEO. FRAS. FITZGERALD.

January 25.

AS I see from a notice of the proceedings of the Academy of Sciences, Paris, in last week's NATURE (p. 287), that MM. Edouard Sarasin and Lucien de la Rive have observed the fact that "multiple resonance" can be obtained by using different sized resonators with a Hertzian "vibrator," I adjoin the following short account of experiments of a somewhat different character made during last autumn, which have led to the same results, and which were brought before the notice of the Dublin University Experimental Association last November. Since then I have learnt what these experimenters also seem not to have known—that some of Hertz's earlier experiments were more especially concerned with this very fact.

First, it was found that the wave-length in the Hertzian experiment of loop and nodes formed by reflection from a large metallic sheet had altered since the apparatus had been last used some months previously. This was attributed at first to something in the "vibrator," such as the width of the spark-gap; but ultimately, on remembering how an accident had necessitated a new resonator being made, the cause was recognized—namely, that it was not exactly the same size as the previous one; and when several resonators of different sizes were made, they were found to give the node at different distances from the reflecting sheet. The intensity of the sparking with which these were affected increased with their size up to a certain point, and then diminished. So that it seems as if a "vibrator" did not send out a "line spectrum," so to speak, but sends out a "band spectrum," the centre of which is the brightest. The period, then, of a "vibrator" is that belonging to the centre of this "band."

Again, in like manner, a "resonator" was always found to give the node in different positions according to the size of the "vibrator" employed. This is what would be expected from the principle of resonance, a resonator being able to respond to any member of the "band" it would itself give out when acting as a radiator, the central period of course with the greatest ease. Some such factor as $\epsilon^{-(\lambda-\lambda_0)^{2n}}$ could, perhaps, express this sort of thing, where λ belongs to the period of the radiation, supposed for the moment "monochromatic," falling on the resonator, and λ_0 belongs to the "period" of the resonator, or that of the centre of its "band."

The position of the node was also found to vary on altering the character of the dielectric surrounding the resonator; even laying a piece of sealing-wax on the wire of the resonator was sufficient to be observed. This might be employed to determine "V" in a dielectric of which only a small quantity was obtainable.

It is obviously of importance for the "central period" of the resonator employed to coincide with that of the vibrator, especially when determining the velocity of the disturbance, for this is presumably the period given by theory. This is practically always done when arranging their relative sizes, so as to obtain greatest intensity. So that the caution urged by M. Cornu in connection with Prof. Hertz's measurements of this velocity seems, from these considerations, to be to a great extent unnecessary.

It would obviously be of importance to investigate what form the resonator should take, so as to give out a radiation most approaching one definite period. FRED. T. TROUTON.

Bourdon's Pressure Gauge.

AS there does not seem to be in any of the more familiar text-books of Physics or Engineering any satisfactory explanation of the action of the Bourdon gauge, the following may be of use to some of your readers.

What we have to explain is the uncurling of the gauge under internal pressure whether of gas or liquid.

Instead of the usual flattened tube of more or less elliptical section

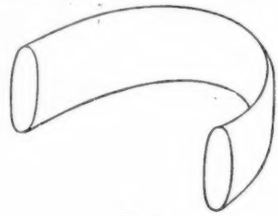


FIG. 1.

bent into the arc of a circle as in Fig. 1, think, for convenience, of one of rectangular section, such as AB of Fig. 2, in which A

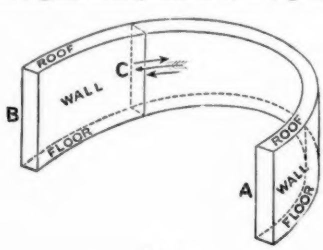


FIG. 2.

is the fixed and B the free end, and in which we shall distinguish, as indicated, the walls, roof, and floor.

If the annulus of tube were complete, as shown in the central cross-section (Fig. 3), then it is evident that under the influence of internal fluid pressure the outer wall would be everywhere in a state of tension in the direction of its length, and the inner wall in a state of compression. In the immediate neighbourhood of the ends A and B this state of compression or extension will be somewhat modified, but at a sufficient distance from either the condition of the walls will be the same as if the annulus really were complete.

If T be the tension of the outer wall in the direction of its length, P the pressure of the inner, and R the resultant fluid pressure on any cross-section such as A or B (Fig. 2), then for the equilibrium of the half of the annulus lying on either side of the diameter AB (Fig. 3) we must have

$$T = P + R.$$

Consider now the equilibrium of any portion BC (Fig. 2) contained between the free end B and a cross-section C at some little distance from B, when the internal pressure is applied, and before uncurling takes place.

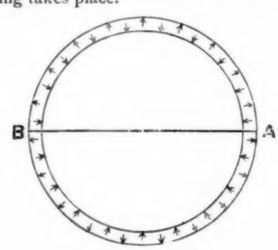


FIG. 3.

Imagine the fluid within BC to be solidified, then the external forces acting on BC (see Fig. 4) reduce to

(1) A tension, T, due to the action of the outer wall beyond C.
(2) A pressure, P, ,, ,, inner ,, ,,
(3) A resultant fluid pressure, R, acting at the centre of pressure of the cross-section C.

and since $P + R = T$, these reduce to a couple tending to uncurl the tube, and the same holds for all sections sufficiently removed from A and B.

As the tube uncurls, however, new forces come into play, viz. the resistance to bending of the walls, but especially of the floor and roof of the tube, whose width in the direction of a principal

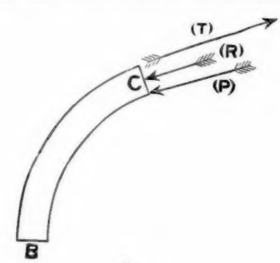


FIG. 4.

radius of the annulus, and consequently whose resistance to bending, is much greater than that of the walls. Uncurling goes on till the moment of the couple resisting flexure is equal to the moment of the bending couple.

It is evident from this explanation that even a tube of circular section would tend to uncurl, but that it would be very insensitive on account of its strength to resist flexure, and that up to a certain point sensitiveness is gained by having the walls of thin material, high, and very near together.

Devonport, December 23, 1889. A. M. WORTHINGTON.

Foreign Substances attached to Crabs.

REFERRING to Mr. F. P. Pascoe's letter (NATURE, December 26, p. 176), I cannot refrain from expressing my astonishment at his inability to "see where protection comes in" in the case of crabs covered with sponges, Polyzoa, &c. I should have thought it obvious to everybody that slow-moving crabs, such as all those he mentions and many others that I have seen, would have a much better chance of escaping their enemies when

covered with material that renders them almost indistinguishable from the stones and gravel in which they are found than if they were naked.

As regards the use of the peculiar hind legs in the Anomoura and *Dorippe*, perhaps the enclosed extract from a paper read by me on December 12 before the Chester Society of Natural Science may be of interest. It will shortly be published in vol. iv. of the Transactions of the Liverpool Biological Society.

ALFRED O. WALKER.

London, W., January 17.

"An interesting fact, illustrating the ingenuity shown by more than one species of Crustacea in concealing themselves, came under my notice last summer. Having dredged a number of Amphipoda, I placed them in a vessel of sea water till I could examine them. Among them I noticed what seemed to be a piece of dead weed swimming rapidly about and occasionally falling to the bottom. Examination with a lens showed that the piece of weed was carried by an Amphipod (*Atylus swammerdamii*), which grasped it by the two first pairs of walking legs (peræopoda). When it came to the bottom the animal concealed itself beneath the weed, which was much larger than itself.

"In connection with this habit of *A. swammerdamii*, it may be mentioned that another species, *Atylus falcatus* (Metzger), resembles the first-named minutely in every respect but one, viz. that the first peræopod has the claw (dactylus) immensely developed, while at the base of the next joint are two or three strong blunt spines or tubercles into which the point of the claw fits. This would appear to give the latter species a great advantage over its congener in grasping an object for purposes of concealment. It is a rare species, but I have met with a few specimens this summer: I am not aware of its having been recorded as British yet.

"In some of the Podophthalmata the same instinct has been observed, and especially among the Anomoura. All these have the last or hindmost pair of legs of a shrunken and apparently almost abortive form. They never appear to be used for walking, and are generally carried turned up on the back; but they are utilized by some species of curiously shaped, flat-bodied crabs (*Dorippe*) to carry the valve of a bivalve mollusk over their backs, under which they can squat and hide. From this it is an easy transition through various stages to the hermit crabs (*Paguridæ*), which ensconce themselves altogether in a univalve shell, and use the curiously abortive hind limbs to cling to the inside whorls. My friend Surgeon-Major Archer has seen crabs of the genus *Dorippe* protecting themselves (probably from the scorching tropical sun), at low tide, on the mud flats at Singapore, by carrying large leaves over their backs (Journal of Linn. Soc., vol. xx. p. 108)."

I CAN corroborate Mr. Ernest Weiss's remarks on the use of the modified legs of Dromia. A small one I had in an aquarium would, when the sponge was removed from the back, hunt about until it found something—a shell, a pebble, or even a dead fish—to replace the sponge. When there was nothing in the aquarium which it could seize, it was evidently in an unhappy condition.

With regard to foreign substances on other crabs, I have caught spider-crabs so completely covered with sponges as quite to hide their shape, and, until they moved, it was impossible to say what they were.

DAVID WILSON-BARKER.

Thought and Breathing.

WITH reference to Prof. Leumann's researches into the influence of blood circulation and breathing on mind life, referred to in NATURE of January 2 (p. 209), it is worthy of note that regulation and suppression of the breath (*Prānāyāma* or *Hatha-Vidyā*), is an all-important religious observance amongst Hindus.

It is one of the eight chief requisites of the Yoga philosophy, for attaining "complete abstraction or isolation of the soul in its own essence," and minute instructions exist for the exercise, which is adopted, apparently, as an immediate aid to deep meditation. Some of these instructions are quoted in Prof. Monier-Williams's recent work on Buddhism (p. 242), and he also quotes, in connection with this subject (p. 241), Swedenborg's opinion that thought commences and corresponds with respiration.

Swedenborg also says:—"It is strange that this correspondence between the states of the brain or mind and the lungs has not been admitted in science."

R. BARRETT POPE.

Brighton.

On the Effect of Oil on Disturbed Water.

HAVING seen the interesting article by Mr. R. Beynon on the above subject (NATURE, January 2, p. 205), shortly before leaving England, I propose to make a few observations on the theoretical aspect of the phenomena described by him.

The simplest case of wave-motion in a viscous liquid arises when two-dimensional waves are propagated in a liquid whose depth is so great in comparison with the lengths of the waves that the former may be treated as infinite. If at any particular epoch, which we may choose as the origin of the time, the form of the free surface is determined by the equation $\eta = \mathrm{A}\epsilon^{\iota mx}$, where $2\pi/m$ is the wave-length, its form at any subsequent time may be represented by $\eta = \mathrm{A}\epsilon^{kt+\iota mx}$, and the object of a theoretical solution is to find the value of k. The equation for determining k is given in the last chapter of my "Hydrodynamics"; and it is there shown that if the viscosity of the liquid be sufficiently small, k will be of the form $-\alpha \pm \iota\beta$, where α and β are *real positive* constants. Hence the equation of the free surface, in real quantities, may be written—

$$\eta = \mathrm{A}\epsilon^{-\alpha t}\cos(mx - \beta t) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which represents periodic motion whose amplitude diminishes with the time, and which therefore ultimately dies away, the rapidity with which the motion decays depending upon the magnitude of α. If, however, the viscosity be large, the solution changes its character, since in this case k is a *real negative* quantity, and the equation of the free surface becomes

$$\eta = \mathrm{A}\epsilon^{-\alpha t}\cos mx \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which represents non-periodic motion, which rapidly dies away.

The phenomena discussed by Mr. Beynon are somewhat different from the special case of deep-sea waves, inasmuch as a thin film of a highly viscous liquid, viz. oil, whose thickness is very small compared with the wave-length, is spread over the surface of water, which is a liquid whose viscosity is so small, that it might probably be neglected altogether. The action of the wind would also introduce an additional complication; but the circumstance that the thickness of the oil is small compared with the wave-length, would, on the other hand, facilitate the calculations which would be necessary in order to obtain a theoretical solution. There can, however, I think, be little doubt that the free surface would be given by equations of the forms either of (1) or (2); where α is so large, that after a short time has elapsed after the film of oil has spread itself over the water, the amplitude of the existing motion would be small compared with that of the original motion.

A. B. BASSET.

Hôtel Beau Site, Cannes, January 11.

Luminous Clouds.

IN the correspondence that has taken place on luminous clouds, totally different classes of phenomena have been mentioned. There are *self-luminous* clouds entirely distinct from what I have termed "sky-coloured clouds," which latter, though by some deemed self-luminous, have been generally admitted to shine by reflecting the direct light of the sun.

The self-luminous clouds described by Mr. C. E. Stromeyer (p. 225) appear to have been a part of the aurora which was visible at the same time; but other correspondents have mentioned self-luminous clouds which have apparently not been of a truly auroral character, and the nature of these clouds seems not to be understood, and requires investigation; there may be various kinds of these and causes of their luminosity. I have myself not unfrequently seen what I call *irregular auroras*, which may be one form of what others call self-luminous clouds. They consist of bands which, unlike regular auroras, appear indifferently in all parts of the sky, and lie in any direction; they are usually much fainter than the Milky Way, and are always feebler near the zenith than near the horizon. The bands composing them are generally parallel, or nearly so, and 3° to 10° wide. They differ from ordinary cirrus in being, so far as I can judge, perfectly transparent, and also in moving extremely slowly, giving one the impression that they are much higher up in the atmosphere than cirrus. Their spectrum is

continuous, though they are sometimes as bright as true magnetic auroras which show the citron line.

The average number of nights on which I have seen these irregular auroras in the past 28 years, chiefly at Sunderland, is 1·9 per annum; and, if doubtful cases are included, 2·7. They agree with magnetic auroras in so far as they show some tendency to an eleven-year periodicity, being most frequent about 2 years after the sun-spot maximum, and least so about 5 years later.

T. W. BACKHOUSE.

Sunderland, January 15.

MR. STROMEYER's letter in NATURE of the 9th inst. (p. 225) reminds me of a magnificent display that I once saw of luminous white clouds, transparent to the stars, which shone brightly through them. These clouds were extended like ribbons from north to south across the sky, in a way not uncommon with true clouds. I thought, and still think, that they were an aurora. May not those described by Mr. Stromeyer have been the same?

Belfast, January 15. JOSEPH JOHN MURPHY.

The Meteorite of Mighei.

WITH reference to the interesting meteorite of Mighei, examined by M. Stanislas Meunier, I have not observed, in any of the notices I have seen, any statement as to whether the organic matter exhibited any traces of an organized structure. I would suggest that, if it has not already been done, it should be carefully examined to see if the carbonaceous matter shows any such traces.

J. RUTHERFORD HILL.

January 11.

Achlya.

I SHALL be very grateful to any of your readers who can send me specimens of *Achlya* with the sexual reproduction, which I cannot at present obtain in my cultures. The culture should be dropped bodily into a cold saturated solution of corrosive sublimate, in a wide-mouthed corked bottle, and this filled up with the liquid to the cork before posting.

MARCUS M. HARTOG.

5 Roseneath Villas, Cork, January 6.

The Parallelogram of Forces.

WHAT is the force of the word "rigid," introduced into the statement and proof of the parallelogram of forces and other theorems in Statics, as quoted by Mr. W. E. Johnson from the ordinary text-books?

The word "rigid" requires definition; it describes a state of things which is not met with in Nature; and it is redundant and limiting; because the conditions of equilibrium of a body are the same, whether elastic to an appreciable extent, or to such an inappreciable extent that the word "rigid" may be applied to it.

Better omit the word "rigid" altogether.

A. G. GREENHILL.

Foot-Pounds.

IN the statics and dynamics paper set in the last Woolwich entrance examination, candidates are asked to determine the magnitude of a moment of a force in *foot-pounds*. Surely it is unfortunate to introduce this term in such a sense. One foot-pound is a unit of work, and though its dimensions (ML^2T^{-2}) are the same as that of a unit of a moment of a force, the two conceptions are perfectly distinct, and the introduction of a foot-pound as a unit of a moment of a force is likely to cause confusion, especially in the minds of beginners.

A. S. E.

Chiff-Chaff singing in September.

IN a review of certain recent ornithological works, in one of your latest issues, doubt seems to be thrown on the fact of the chiff-chaff singing late in September.

I believe it is not an unusual occurrence. It always nests in my garden, and this year, as I see by a note made at the time, it sang on the 20th, 21st, and 22nd of that month. We had a slight frost on the 21st.

F. M. BURTON.

Highfield, Gainsborough, January 6.

EAST AFRICA AND ITS BIG GAME.[1]

FOR sporting purposes Cape Colony and the adjoining districts are long ago "used up," and the hunter who would fain see "big game" must follow Mr. Selous into Matabelé-Land and Mashoona-Land, if he does not find it better to cross the Zambesi. Even here, some of the largest animals are already exterminated. The redoubted hunter whose name we have just mentioned has not met with a White Rhinoceros during the past four seasons, and his "bag" of ivory shows a yearly diminution. So much for the south of the Dark Continent. The northern entrance to the great Interior, which afforded Sir Samuel Baker and those who followed him such splendid sport on the Atbara and Settite, has been closed up by the Mahdists, and until we have made up our minds to "clear out Khartoum," no European can hope to penetrate in this direction. There remains, therefore, only the eastern coast as a mode of access to the wild interior of game-tenanted Æthiopia, the west coast being practically closed by swamps and fevers.

On the eastern coast of Africa, however, immediately under the equator, a splendid stretch of high-lying land, full of big game, and easy of access, is still open to the enterprising sportsman. First made known to us by the German missionaries Rebmann and Krapf, the "Kilimanjaro District," as it is now usually called, was subsequently opened to us by Von der Decken, New, and Hildebrandt. To these explorers succeeded Mr. Joseph Thomson on his route to Masai-Land, and Mr. H. H. Johnston on his expedition up the Kilimanjaro Mountain, to which Dr. Hans Meyer and other more recent travellers have also devoted their special attention. Access to this sportsman's paradise is rendered easy by the port of Mombas, now under the benign sway of the British Imperial East African Company, and connected with Aden by a regular line of steamboats. Here, in the autumn of 1886, having made the necessary preparations at Zanzibar, the author of the present volume, with his brother sportsmen Sir Robert Harvey and Mr. H. C. V. Hunter, assembled their caravan. Their plan was to reach as quickly as possible the forest of Taveta, distant about 250 miles from the coast and within ten miles of the base of Kilimanjaro, and having established their head-quarters in this favoured spot, to work thence the surrounding plains and open country. Mr. C. B. Harvey, the brother of Sir Robert, was to join them when his leave commenced, a month later.

How well this programme was carried out the entertaining pages of Sir John Willoughby's narrative fully explain to us, while the map at the commencement clearly shows the route and the nature of the different districts traversed, as they appeared to the eyes of the enthusiastic sportsmen. Much time and trouble was saved to the expedition by the selection of a Maltese named Martin as "chief of the staff." Martin had accompanied Mr. Thomson during his adventurous journey into Masai-Land, and was, moreover, the owner of a "freehold building-site" at Taveta. Hereon was a house and a range of huts, forming three sides of a large square, while the fourth was bounded by a sparkling rivulet well stocked with fish. Such a haven of refuge, protected, as it was, by a thorn-hedge with a strong gateway, and situated in the immediate vicinity of a good game-country at an elevation of 2400 feet above the sea-level, seemed little less than a Paradise to our travellers, who arrived here on December 26, about sixteen days after leaving Mombas. Into their various excursions from this convenient centre we need not closely follow them. Suffice it to say that their routes were

[1] "East Africa and its Big Game, the Narrative of a Sporting Trip from Zanzibar to the Borders of the Masai." By Captain Sir John C. Willoughby, Bart., Royal Horse Guards. With Postscript by Sir Robert G. Harvey, Bart. Illustrated by G. D. Giles and Mrs. Gordon Blake; those of the latter from photographs taken by the Author. (London: Longmans, 1889.)

mostly to the west of Taveta, amongst the numerous streams that drain the southern slopes of Kilimanjaro and unite to form the Ruvu River, which enters the sea at Pangani, and to the east of the great mountain on the head waters of the Tzavo. These various hunting expeditions occupied the time until April 21, when a safe return was effected to Mombas, and thence to Europe.

The list of larger game-animals killed by the party during their four months shows a goodly total of 330 head, although we are assured by Sir John Willoughby that no useless slaughter was perpetrated during the expedition, and that no animal was killed unless required for a specimen, or for food by the hunters and their native companions. In the list of these 330 animals, we find 21 Buffaloes, 66 Rhinoceroses, 2 Elephants, 4 Hippopotamuses, 4 Zebras, and 211 Antelopes of different species. But a much more attractive list to the naturalist will be found in the appendix "on the fauna of the plains round Kilimanjaro," compiled by Mr. Hunter. So little is yet known of the larger mammals of this fine country, except from fragmentary notices, that Mr. Hunter's notes, brief as they are, form a not unimportant contribution to zoological science. Lions, Elephants, Hippopotamuses, and Giraffes are prevalent alike in every part of Wild Africa, but the splendid Bovine animals called Antelopes vary very materially in the different districts. In the Kilimanjaro country, sixteen Antelopes are recorded as having been met with, and amongst them are some of the finest and largest of the whole group. The Eland (*Oreas canna*) is "rather local," but there "are a fair number to the south of the mountain." The Eland found here belongs to the variety called Livingstone's Eland, first met with by that great explorer on the Zambesi. "Both males and females are all more or less striped." The Larger Kudu (*Strepsiceros kudu*) was "only seen on two or three occasions on the Useri River"; the Lesser Kudu (*S. imberbis*) is found "in the bush around Taveta," and in several other localities. Two examples of this until lately little-known Antelope from this district are now living in the Zoological Society's Gardens. The Beisa (*Oryx beisa*) is "plentiful on the plains and in thin thorny bush"; the Coke's Hartebeest (*Alcelaphus cokii*) is "quite the most common Antelope on the plains, being found everywhere in immense herds"; while the Brindled Gnu (*Connochætes gnu*), the Mpallah (*Æpyceros melampus*), and the Waterbuck (*Cobus ellipsiprymnus*) are, according to Mr. Hunter, abundant in appropriate localities. We suspect, however, that Mr. Hunter's so-called "Waterbuck" is the Sing-sing (*Cobus sing-sing*), of which some fine heads were procured by Mr. Holmwood, lately H.B.M. Consul at Zanzibar, during an excursion to the Tavita district. Of the beautiful tribe of Gazelles, three well-marked species, all recently discovered and appropriately named after distinguished African travellers, tenant the plains of Kilimanjaro. These are the Grant's Gazelle (*Gazella granti*), the Thomson's Gazelle (*G. thomsoni*), and the Waller's Gazelle (*G. walleri*). Grant's Gazelle is "common everywhere on the open plains." Its fine lyre-shaped horns attain a larger development than in perhaps any other species of the genus. Their elegant shape and prominent outlines will be seen by the accompanying figure from the Proceedings of the Zoological Society. Thomson's Gazelle was found in large numbers in the plains of the Masai country to the south-west of the mountain. Waller's Gazelle was "very rare near Kilimanjaro," but subsequently found to be numerous up the Tana River. One was killed near Lake Jipé. But the great prize among the Antelopes was met with by Sir Robert Harvey and his companions Messrs. Greenfield and Hunter, during a subsequent expedition to Eastern Africa. In the course of this journey they ascended the River Tana, which forms the northern boundary of the dominions of the British Imperial East African Company. Here, on the northern bank, they came across specimens of an entirely new Antelope, "of a bright red colour, in some respects resembling a Hartebeest, especially in regard to the length of its head, and of about the same size, but hardly so high at the withers." This

FIG. 1.—Head of Grant's Gazelle.

FIG. 2.—Head of Hunter's Antelope.

Antelope has been since named Hunter's Antelope (*Damalis hunteri*) by Mr. Sclater (see Proc. Zool. Soc., 1879, p. 372, Pl. xlii.), and mounted specimens of it may be seen in the Mammal Gallery of the Natural History Museum at South Kensington.

It must not, however, be supposed that the rich mammal-fauna of the Kilimanjaro district has been yet entirely exhausted. We read, in Sir John Willoughby's narrative, of a Duiker Antelope (*Cephalophus*), of a dark red colour, found on the mountain, of which a specimen was obtained by an American traveller, Dr. Abbott, but not by the British sportsmen. On the same mountain, at an elevation of about 9000 feet, Dr. Abbott also secured an example of an "extraordinary animal" like a Serow (*i.e. Capricornis bubalina* of the Himalayas), but "darker in colour and shorter on the legs." There is therefore ample room for future discoveries, both in this and in other branches of natural history. The plateau surrounding Mount Kenia, which has yet to be explored scientifically, would doubtless supply many other novelties. In short, at the present time we know of no other field for zoological discovery so promising and so easily accessible as the slice of Eastern Africa recently assigned to Sir William Mackinnon and his associates of the B.I.E.A. Company, to which the author of the present volume has given us such a useful and agreeable introduction.

THE CORAL REEFS OF THE JAVA SEA AND ITS VICINITY.[1]

SINCE comparatively few of the naturalists who have sojourned in the Indian Archipelago have paid special attention to the coral reefs of that region, it becomes a cause of satisfaction that Dr. C. Ph. Sluiter, of Batavia, who has long been engaged in studying the marine fauna of his neighbourhood, has taken up the subject in earnest. In a paper on the origin of the coral reefs of the Java Sea, and of Brandewijns Bay on the west coast of Sumatra, and on the new coral formations of Krakatão, Dr. Sluiter gives the results of his recent preliminary investigations.[2] This paper is excellent in method, and the results of the highest importance.

In the western half of Batavia Bay, where the depth varies from 5-12 fathoms, there are numerous coral reefs which occur in all stages of growth from the incipient reef to the coral island begirt with a barrier-reef. Being curious to learn how the corals first began to grow on the muddy bottom of this bay, the author of this paper soon found an explanation in the fact that the stones and fragments of sunken Krakatão pumice, which lay in places on the mud, were covered with living corals. Hence he concluded that in those favourable circumstances where several of the stones and pumice fragments lay close together we might have the beginning of a reef. A singular feature in the growth of these reefs then attracted his attention. Some fourteen years ago, an artesian boring was made in the small coral island of Onrust in Batavia Bay, when an accumulation, 20 metres thick, of coral *débris*, shells, and clay, was found to pass downward into a firmer clay. The depth of the sea around is only 11 metres, and after allowing about 2 metres for the height of the island, Dr. Sluiter infers that the coral fragments have sunk down 7 metres into the mud or clay of the sea-bottom.

To support this view, the author gives a section of the shore-reef of Brandewijns Bay, on the west coast of Sumatra, the section being constructed from data supplied by fifteen borings, none deeper than 24 metres, the reef there being rather under 300 metres wide. As is there shown, the volcanic formations of the steep coast-border descend at a precipitous angle under the sea, so that they do not form a foundation for the shore-reef. This reef, the thickness of which varies greatly, being in some places as much as 11 metres and in others only half that amount, lies on "a substratum of clay or mud mixed with coral *débris*, and forming a bed ranging from 2 to 7 metres in thickness." This substratum of clay and coral passes down into a clay or mud, formed from the decomposed andesitic rocks of the district, which may be firm in some places and soft in others. The next point brought out in the section is that the substratum of clay and coral *débris* is thickest and deepest where the underlying clay is soft, and thinnest and nearest to the surface when the clay is firm or is mixed with sand. From these and allied considerations, Dr. Sluiter passes on to the conclusion that the same process has taken place here which occurs in the construction of dams and piers on a yielding bottom, a large amount of coral materials having been sunk in the mud, whilst the reef, by its own weight, has prepared its own foundation.

Having been familiar with the appearance of Krakatão before the great eruption of 1883, Dr. Sluiter observed some interesting changes in connection with the shore-reefs of this island when he revisited it in 1888 and 1889. The pumice and ashes at the time of the outbreak, according to the account of Dr. Verbeek, the historian of the eruption, destroyed all life in the sea around, making the sea-bottom a lifeless waste; and under an accumulation, 20 metres thick, of these materials lies the old shore-reef. In 1888 and 1889 the old condition of things was beginning to re-assert itself. In one place a young shore-reef, composed mostly of madrepores, had attained a breadth of a metre, and living corals were brought up in abundance by the dredge, attached to sunken pumice. Amongst the measurements of coral growth given by the author are those relating to specimens of *Madrepora nobilis*, Dana, which had attained a length of from 2 to 2½ decimetres in a period that could not have exceeded five or six years, and was probably much less. Specimens of *Porites mucronata*, Dana, had also in the same period grown to a length of 1 decimetre.

After referring briefly to the interesting Thousand Islands, a linear group of small coral islands near Batavia, many of which, in the southern part, affect the atoll form, Dr. Sluiter sums up the results of his observations. A coral reef in the Java Sea *commences its growth on a muddy bottom* in the form of a colony of corals growing on the *stones* and *sunken pumice* that there lie. As it increases in extent and height, it secures its own foundation by its weight, a large amount of coral materials sinking into the mud to a depth of seven or less metres. In its upward growth it presents a level top, and displays no hollow or basin, a uniformity which it preserves until a foot from the surface, when it dies in the centre, and the agencies dwelt upon by Murray and Agassiz then co-operate in forming an atoll or a barrier-reef. Because the small coral reefs (500 metres wide) of the Java Sea grow up uniformly until near the surface, Dr. Sluiter places himself in partial antagonism to a portion of Murray's theory. In this, however, he has missed the point of the new view, according to which such small reefs would either have no lagoon or else possess a very shallow one. With this correction, his partial confirmation of Murray's theory becomes more complete.

We hope that, with the great facilities at his disposal, Dr. Sluiter will make an exhaustive examination of the Thousand Islands, the varied and unusual conditions of their growth rendering them particularly important as a field for thoroughly investigating the problem.

H. B. GUPPY.

[1] "Einiges über die Entstehung der Korallenriffe in der Javasee und Branntweinsbai, und über neue Korallenbildung bei Krakatau." Von Dr. C. Ph. Sluiter (Batavia en Noordwijk: Ernst and Co., 1889.)

[2] *Natuurkundig Tijdschrift voor Nederlandsch Indië*, Band xlix.

THE ELECTRIC LIGHT AT THE BRITISH MUSEUM.

THE authorities of the British Museum are to be congratulated on the thorough and admirable manner in which the scheme for the electric lighting of the galleries has been carried out. Everyone present at the private view on Tuesday evening was pleased with the results which had been achieved. Both arc and glow lamps are employed; the former in the galleries on the ground floor containing Greek and Roman sculpture, the Elgin marbles, and Assyrian and other antiquities, and in some galleries on the upper floor. The suite of bronze and vase rooms on the west, and the ethnographical gallery on the east, of the upper floor are lighted by glow lamps. The light from glow lamps is more agreeable to the eyes than the more powerful light of arc illuminants; but these have been regulated with the utmost care, and on Tuesday evening there was a very general feeling that the beauties of the sculpture were brought out by them more effectually than by such daylight as is at times rendered possible by our northern climate. With regard to the arc lights on the upper floor, it was noticed that they were admirably adapted for the exhibition of the Japanese drawings, even the minutest details of these delicately finished works being rendered plainly visible without any diminution of the beauty of the colours.

We quote from the *Times* of January 29 the following description:—

"In the galleries on the ground floor there are 69 arc lamps of various powers, while on the upper floor there are 57 arc and 627 glow lamps. In addition to these there are five large arc lamps in the reading-room, six in the court-yard, and upwards of 200 glow lamps in the offices and passages. The total current required to work the whole of the lamps is nearly 1200 amperes, with an E.M.F. of 115 volts at the lamp terminals; and this output is produced by the expenditure of nearly 200 brake-horse-power. The current is generated by four Siemens dynamo machines, each capable of giving an output of 450 amperes and 130 volts, which are connected to a general switchboard in the engine-room by means of which they can be put to work in parallel to any or all of the circuits. The switchboard is fitted with instruments indicating the current given off by each dynamo and four circuits are led from it round the Museum—two for the upper and two for the lower floor. The main wires are laid outside the building. In order to insure safety, and to guard, as far as possible, against failure of light, the motive power is in duplicate. The four dynamos are driven in pairs, each pair by a separate engine with a separate countershaft. Each engine has a separate steampipe in direct communication with the boilers, and there is an ample reserve of boiler power. The power of the engines and dynamos is so adjusted that each of the two sets is capable of working the whole of the lamps in those galleries proposed to be lighted on any one evening; the other set standing by ready to work. Further, in order to work if required, at half-power, or in order to provide half-light for the whole of the galleries—which light should suffice for an emergency such as sudden fog or accident—the lamps are connected in pairs alternately, so that half of the number being cut off, the light of the other half still remains evenly distributed. The engines have been supplied and erected by Messrs. Marshall, Sons, and Co. (Limited), of Gainsborough, and the electrical work has been executed by Messrs. Siemens Brothers and Co. (Limited)."

The eastern and western portions of the Museum will be open to the public on alternate week-day evenings, and all the world agrees with the *Times* that "the educational value of the unique collections of art and scientific treasures the Museum contains will be greatly enhanced by the change."

NOTES.

THE Medals and Funds to be given at the anniversary meeting of the Geological Society on February 21 have been awarded by the Council as follows: the Wollaston Medal to Prof. William Crawford Williamson, F.R.S.; the Murchison Medal to Prof. Edward Hull, F.R.S.; and the Lyell Medal to Prof. Thomas Rupert Jones, F.R.S.; the balance of the Wollaston Fund to Mr. W. E. A. Ussher, of the Geological Survey of England; that of the Murchison Fund to Mr. Edward Wethered; that of the Lyell Fund to Mr. C. Davies Sherborn; and a portion of the Barlow-Jameson Fund to Mr. William Jerome Harrison.

THE Council of the Royal Meteorological Society have arranged to hold at 25 Great George Street, Westminster, on March 18 to 21 next, an Exhibition of Instruments and Photographs illustrating the application of photography to meteorology. The Exhibition Committee invite co-operation, as they are anxious to obtain as large a collection as possible. They will also be glad to show any new meteorological instruments or apparatus invented, or first constructed, since last March; as well as photographs and drawings possessing meteorological interest. Anyone willing to co-operate in the proposed Exhibition should furnish the assistant secretary (not later than February 12) with a list of the articles he will be able to contribute and an estimate of the space they will require.

THE second course of the Gifford Lectures at Glasgow will begin on February 5. As announced in the first course, these lectures will treat of what Prof. Max Müller calls "Physical Religion," or the belief in natural, sub-natural, and super-natural powers, discovered in some of the great phenomena of Nature.

SOME most interesting notes on the last days of Father Perry are contributed to the *Tablet* of January 25 by Father Strickland, S.J. The facts stated by the writer bring out in a very striking light the earnest and resolute spirit in which, to the end of his life, Father Perry devoted himself to science. During the voyage he suffered badly from sea-sickness, and on his arrival at the Isles de Salút he was "much done up." Nevertheless, he allowed himself no rest, but landed at once to view the site and introduce himself to the authorities. Captain Atkinson urged him to live on board the *Comus* and land each morning for his work; and Father Strickland is of opinion that if he had done this "his life would not have been sacrificed to his over-anxious desire to do everything for the best for the success of the work confided to him." He preferred, however, to take up his quarters in the hospital, and said nothing about the fact that he was in bad health, making "light of all his personal wants for fear of giving trouble to others." The observatory erected for the occasion was half a mile from the hospital, and "the intervening ground was very rough, being a steep descent and ascent, and the distance was gone over on foot four times each day in fair weather or foul." "On the Friday before the eclipse Father Perry complained of being 'very bad inside,' but he worked on until nearly 3 a.m., and when the men retired to the *Comus* he tried to snatch a little rest where he was, and lay down in a hammock in the tent. He was up again before 6 o'clock to take the position of the sun at rising. At 6.45 the men arrived from the ship, and at 7.30 there was a complete, most careful, and most successful rehearsal of all the operations and duties which were to be performed next morning in the solemn moments of the eclipse, for which they had been preparing so long and had travelled so far. Everyone was surprised at Father Perry's exactitude in contributing to carry out his own orders and his courage in facing fatigue. His readiness to sacrifice himself and his own convenience in order to save trouble to others endeared him to all who worked with him, and challenged their utmost efforts to secure success for their work in

spite of the oppressive climate and surroundings. Just before noon on Saturday, Lieutenant Thierns went to see him at the hospital and found him much exhausted; but he was again at his post in the observatory at 3 p.m., at which time an important photograph was secured with the mirror. In the evening he went on board the *Comus* for dinner, but was only able to lie on a sofa all the time; and he sent to the doctor for some chlorodyne. Much against the wishes and earnest advice of Captain Atkinson (who spoke to me of Father Perry with the sincerest regard and esteem), Father Perry made his way on shore in a violent pouring rain to sleep in his own quarters, and would allow no one to hinder him. Next morning, Sunday the 22nd, was the important moment of the eclipse. Lieutenant Thierns landed with his observatory party at six o'clock, and on arrival was informed by Mr. Rooney that Father Perry had passed a very bad night and was very ill, so a man was sent to help him over the bad half mile from his quarters, as he declined to let himself be carried on a stretcher. He reached the observatory in good time, though in a very exhausted state. As the important moment approached, he seemed to rally, and, during the minutes of the eclipse, seemed to be himself again, and showed no signs of illness or exhaustion. There were two photographic instruments in use—one an old one, which had often been in use before, the other was the special new corona graphic instrument prepared for the occasion, of which Father Perry himself took charge. He was so alert and self-possessed during the eclipse, that his friends about him hoped he was not so ill, but he gave way immediately after, and with much difficulty reached his quarters in the hospital. It was known after, that during the previous night he had been very seriously ill." On Sunday night it became evident that he was suffering from the very worst form of dysentery. On Wednesday, Christmas Day, he was better, and the vessel started for Demerara. All hope was gone on Friday at 1.30 p.m. At 3 p.m. his mind began to wander, and at 4.20 he died. It is pathetic to read that before he quite lost consciousness he thought himself again engaged in "the supreme moment of the scientific mission which had so long filled his thoughts," and "began to give his orders as during the short minutes of the eclipse."

AT its annual sitting, the Russian Academy of Sciences elected the following as Corresponding Members:—In Mathematics, Prof. Sophie Kovalevskaya, Stockholm; in Astronomy, Prof. Moris Lœwy, Paris; in Chemistry, Prof. Stanislas Cannizaro, Rome; in Biology, Th. Keppen, Russia, and Prof. Henri Baillon, Paris.

THE Sanitary Institute has made arrangements for the ninth course of lectures and demonstrations for sanitary officers. They will be given in the Parkes Museum, and will be specially adapted for candidates preparing for the Institute's examination for inspectors of nuisances. The introductory lecture will be delivered on February 18 by Mr. E. C. Robins. Among the lecturers will be Sir Douglas Galton and Prof. W. H. Corfield. The former will lecture on ventilation, measurement of cubic space, &c; the latter on sanitary appliances.

MESSRS. MACMILLAN AND CO. are issuing a monograph of the British Cicadæ, by George Bowdler Buckton, F.R.S. It will consist of eight quarterly parts, each containing on an average ten litho-chromo plates and letterpress, illustrating the forms, metamorphoses, general anatomy, and the chief details connected with the life-history of this family of insects. The work will contain also short diagnoses of all the British species, about 230 in number, most of which have come under the author's notice, each species being illustrated by one or more coloured drawings. Some account will be given of the curious myths and tales told by ancient Greek and Latin poets, and descriptions will be appended relating to the curious sound-organs possessed by some species, and other subjects connected with the economy of this interesting but difficult group of Rhynchotous insects.

MESSRS. MACMILLAN AND CO. have in the press a "Manual of Public Health," by Mr. Wynter Blyth, M.R.C.S., Medical Officer of Health for St. Marylebone.

MALTA has suffered a great loss in the almost sudden death of Dr. Gulia, Professor of Botany, Hygiene, and Forensic Medicine in the Royal University of Valletta. He was born, in 1835, at Cospicua, a suburb of Valletta, where his father was a physician. He graduated in medicine and surgery, in 1855, at Valletta, and afterwards went to complete his studies at Paris, where he made the acquaintance of a large number of eminent men, including Milne-Edwards, Blanchard, and Vidal. On his return to reside in his native town, he was elected to the above-mentioned Chair in the University in Valletta. Besides attending to his professorial duties and the requirements of a large medical practice, Prof. Gulia found time to edit an important medical journal, in which he exhibited great literary and scientific talents. He also issued, among other writings, a "Flora of Malta." His son is about to publish his last work, containing the completest account of the flora of Malta up to the present time, bringing the total number of species up to 833.

AT a meeting of the Society of Arts, last week, Mr. Brudenell Carter read a valuable paper on "Vision-testing for Practical Purposes." Referring to colour blindness, Mr. Carter said that Dr. Joy Jeffries, in the last edition of his work on the subject, tabulates the results of the examination of 175,127 persons, and shows that the percentage of this number who were colour blind amounted to 3·95. Any method of examination which gives a percentage differing from this in any marked degree must, Mr. Carter thinks, be vitiated by some error. Of the methods of examination pursued on the English and Scottish lines of railway, and by the Board of Trade, he said they had one feature in common—they were all wrong, "the direct offspring, in almost every instance, of a degree of ignorance and presumption, the very existence of which would be incredible if the proofs of it were not brought daily under our observation." "Even where the use of Holmgren's method is professed," said Mr. Carter, "the rules laid down by Holmgren for conducting it are, as a rule, utterly ignored, and the results obtained are as utterly misleading. The test should be used in exact conformity with his very detailed and precise instructions, or it should not be used at all."

THE first of a series of Friday evening lectures on Astronomy was delivered on Friday, the 24th instant, by Mr. E. J. C. Morton, at the Battersea Public Baths. An audience numbering over 400 assembled, and manifested much interest in the subject with which Mr. Morton dealt. The lectures are being given in connection with the University Extension Scheme.

THE following science lectures will be given at the Royal Victoria Hall during February: 4th, "Algeria and Morocco," by Mr. Henry Blackburn; 11th, "Arsenic," by Mr. Ward Coldridge; 18th, "Eyesight and Some of its Defects," by Dr. Collins; 25th, "Sinai and Palestine," by Sir Charles Wilson.

The third series of lectures given by the Sunday Lecture Society will begin on Sunday afternoon, February 2, in St. George's Hall, Langham Place, at 4 p.m., when Dr. B. W. Richardson, F.R.S., will lecture on "The Health of the Mind; and Mental Contagions." Lectures will subsequently be given by Sir Henry E. Roscoe, M.P., F.R.S., Mr. Justin H. McCarthy, M.P., Mr. G. Wotherspoon, Mr. H. L. Brækstad, Mr. Louis Fagan, and Dr. James Edmunds.

GREAT efforts are being made to secure that the eleventh meeting of the National Electric Light Association, to be held

at Kansas City from February 11 to 14, shall be, as *Science* puts it, "one of the most interesting conventions ever held." Those who propose to go to Kansas from New York may look forward to a pleasant journey. A vestibule train, to be called the Electric Limited, is to run through without change to Kansas City *viâ* Chicago and the Chicago, Burlington, and Quincy Railroad. The committee making the necessary arrangements feels confident that this train will be "the finest ever run out of New York." It will be composed of the latest Pullman vestibule sleeping-cars, lighted by electricity, a dining-car, composite car containing barber shop, bath room, card room, library, writing desk, smoking room, &c., and an observation car with a large open room luxuriously furnished, as well as an observation platform. The train will be supplied throughout with fixed and portable electric lamps.

HERR TRAUTWEILER thinks that a railway should go to the top of the Jungfrau, and in the *Schweizerische Bauzeitung* gives a brief account of his scheme. The railway would go from the valley below to the summit, and would be almost entirely underground. There would be several intermediate stations, from which convenient, well-arranged tunnels would lead to points on the mountain whence the best views are to be had. If stormy weather came on, the passengers could withdraw into the shelter of those tunnels. The railway would be lighted by electricity.

THE following is translated from a notice published by the authorities of the Madrid Observatory:—"D. Ernesto Caballero, Professor of Physics, and director of the electric lighting manufactory in Pontevedra, writes to this Observatory, giving details of a remarkable meteorological phenomenon which appeared at 9.15 p.m. on the 2nd inst. In a sky serene and clear, there appeared suddenly a globe or ball of fire of the apparent size of an orange, which after falling (it is not possible to well indicate how or from whence) upon the conducting wires stretched across the city, entered the manufactory (referred to) by a skylight or window, struck the apparatus for distributing the light, from which (after raising the armature of a magnetic current closer) it struck the dynamo at work. In the presence of the alarmed engineer and workmen present it rebounded twice from the dynamo to the conductor, and from the conductor to the dynamo, then fell and burst with a sharp and clear detonation into a multitude of fragments, without producing any harm or leaving any trace of its mysterious existence. In various parts of the city the lights swiftly oscillated and were extinguished for some seconds, and that the darkness was not general and long continued was owing to the admirable self-possession of the *employés*, who almost instantly established the order of things so suddenly and strangely interrupted by this mysterious meteor, of whose action and presence there only remained traces on the melted (or soldered) edges of the thick copper plates belonging to the armature of the circuit closer. Outside the building, and at the moment of falling upon the conducting wires, it was seen by (among others) the Professor of Natural History, Señor Garcéran, and from various effects observed on the wires during the following day there were undoubted manifestations (in no other way explicable) of its electrical origin."

THE second part of a voluminous bibliography of meteorology prepared by Brigadier-General Greely, Chief Signal Officer of the United States Army, and edited by Oliver L. Fassig, has been issued, and consists of a classed catalogue of printed literature relating to moisture, from the origin of printing to the close of 1881. The whole literature included is divided into 22 subdivisions, a comprehensive classification which will be highly appreciated. A section is devoted to rainfall in general, others to distribution and variation of rainfall, others to heavy rainfall and drought, and so on throughout the whole work. A division on "Showers of Miscellaneous Matter," though not properly a part of the subject, has been deemed of sufficient interest in connection with the general subject of precipitation to be included within this volume. Although supplements to Part I. Temperature, and Part II. Moisture, may appear later, it is to be regretted that it will be impracticable for any other part of this bibliography to be issued from the Signal Office.

IN *Petermann's Mitteilungen* for December last, Dr. R. Spitaler has an instructive paper on the temperature "anomalies" of the surface of the earth in January and July, with charts showing those districts which are too warm (in positive anomaly) or too cold (in negative anomaly), compared with the normal values of their geographical positions. Such charts were first drawn by Dove; but as the materials at the disposal of Dr. Spitaler are much better than those which Prof. Dove possessed, the charts differ in several important particulars. The influence of the warm and cold ocean-currents upon the temperature anomaly is very clearly shown. Europe, for instance, being under the influence of the Gulf Stream and south-west winds, is always in positive anomaly, whereas Central Asia is a district which has in winter 24° C. of negative anomaly, while in summer it has 6° of positive anomaly, or of greater heat than the same latitude in Europe. The July chart shows in the northern hemisphere two decided maxima of positive anomaly, and two minima, while in the southern hemisphere, owing to the less amount of land, the anomaly is much smaller. In July the continents of the northern hemisphere are almost entirely in positive anomaly, while the whole of the Atlantic and Pacific Oceans and Central America are in negative anomaly.

IN the current number of the Journal of the Anthropological Institute there is a valuable paper, by Dr. Arthur Thomson, on the Veddahs of Ceylon. Discussing the affinities of the Veddahs, he says there appears to be little doubt that if they be not of the same stock as the so-called aborigines of Southern India they at least present very strong points of resemblance as regards stature, proportions of limbs, cranial capacity, and form of skull. The similarities of hair and colour between these races have often been remarked, so that, on the whole, if physical features alone be taken into account, Dr. Thomson thinks the affinities of the Veddahs with the hill tribes of the Nilgherries and the natives of the Coromandel coast, and the country near Cape Comorin, are fairly well proved.

MR. H. B. BASHORE sends to *Science* sketches of an interesting Indian pipe. It is made of dark green steatite, carved into an admirable image of a turtle, and represents, no doubt, one of the Delaware totems. The back of the animal is well polished and distinctly marked with lines, and the hole for the stem is well drilled, and of a smooth bore. This relic was found thirty years ago on the site of what is now the village of Fairview, on the Susquehanna, close to an old Indian burying-ground.

THE Punjab Government is obtaining a number of young olive trees from Italy, and proposes to find out by experiment whether the low hills below Murree in the Rawul Pindi district are suitable for olive cultivation.

THE Laccadive Islands have been suffering severely from a plague of rats. According to the Calcutta Correspondent of the *Times*, these invaders have destroyed the cocoanut plantations and reduced the islanders to a state of destitution.

MR. R. M. JOHNSTON lately called the attention of the Royal Society of Tasmania to the extreme variability of the genus *Unio*, inhabiting the northern rivers of Tasmania. The shell seems to be capable of a remarkable number of modifications with regard both to form and colour. This, Mr. Johnston says, is more particularly the case if specimens marking different stages of growth are compared with each other. In specimens

marking seven stages of growth, the variation in form—from youth to the adult stage—embraces characteristics covering "most of the distinctions upon which many of the Australian forms mainly depend for the recognition of distinct specific rank." Such being the variability of local form in the individuals of the various stages of growth, Mr. Johnston thinks there is good reason for the belief that the several forms erected into specific ranks in various parts of Australia may prove to be local varieties, or particular stages of growth of one widely distributed species.

THE destruction of the native opossum is attracting some attention in Tasmania. It is said that about 75 per cent. of the animals killed have had young in the pouch at the time. The opossum has great commercial value, and there seems to be a general opinion that it ought to be efficiently protected.

IN the third report of the Liverpool Marine Biological Station on Puffin Island, Prof. W. A. Herdman gives a concise and interesting account of much good work done during the past year. In the autumn the station was closed, but it will be re-opened at the beginning of either April or May, and Prof. Herdman has no doubt that next summer all the different lines of investigation hitherto started will be followed up with a renewed enthusiasm which will more than make up for the loss of the winter observations.

THE *Annuaire de l'Académie Royale de Belgique* for the current year contains the usual information about the Academy and the awards of the various prizes. There is little to interest non-members except the series of biographies and portraits of former distinguished members, including Houzeau.

DR. C. HART MERRIAM, chief of division of ornithology and mammalogy, in the U.S. Department of Agriculture, has issued a series of directions for the measurement of small mammals and the preparation of museum skins. The directions are accompanied by an illustration, showing the appearance of a well made skin.

MR. DE ZILVA WICKREMASINGHE, assistant librarian of the Colombo Museum, has compiled a valuable list of the "Pansiyapanas Játaka," the 550 birth stories of Gautama Buddha. In order to make the record complete the compiler consulted many old manuscripts belonging to temple libraries in various parts of Ceylon. The list has been published in the Journal of the Ceylon branch of the Royal Asiatic Society, and is also printed separately.

SOLUTIONS to the questions in Pure Mathematics, Stages I. and II., set at the May examinations of the Science and Art Department from 1881 to 1886, have been published by Messrs. Chapman and Hall in book form. Each of the questions has been fully worked out, and together they make a useful series of examples in elementary mathematics.

MESSRS. DULAU AND CO. have issued a catalogue of works relating to cryptogamic botany.

WE have to acknowledge receipt of £2, sent by Mrs. Morton Sumner towards the payment of the debt on the laboratories of Bedford College, to which we called attention last week.

AN interesting paper is contributed by Prof. Carnelley to the *Philosophical Magazine* for January, in which he attempts to express the periodic law of the chemical elements by means of an algebraic formula. For reasons which are given in detail in the memoir, an expression of the form $A = c(m + \sqrt{v})$ is adopted, where A represents the atomic weight of the element, c a constant, m a member of a series in arithmetical progression, depending upon the horizontal series in the periodic table to which the element belongs, and v the maximum valency or the number of the vertical group of which the element is a member. From a number of approximations, Prof. Carnelley finds that m is best represented by the value 0 in the lithium-beryllium-boron &c., horizontal row, by $2\frac{1}{2}$ in the sodium series, 5 in the potassium series, and $8\frac{1}{2}$, 12, $15\frac{1}{2}$, 19, $22\frac{1}{2}$, &c, in the subsequent rows. Thus m is a member of an arithmetical series of which the common difference is $2\frac{1}{2}$ for the first three members, and $3\frac{1}{2}$ for all the rest. On calculating the values of the constant c from the equation $c = \dfrac{A}{m + \sqrt{v}}$ for 55 of the elements, the numbers are all found to lie between 6·0 and 7·2 with a mean value of 6·6. In by far the majority of cases the value is much closer to the mean 6·6 than is represented by the two extreme limits, thus in 35 cases the values lie between 6·45 and 6·75. If the number 6·6, therefore, is adopted as the value of c, and the atomic weights of the elements are then calculated from the formula $A = 6{\cdot}6(m + \sqrt{v})$, the calculated atomic weights thus obtained approximate much more closely to the experimental atomic weights than do the numbers derived from an application of the atomic heat approximation of Dulong and Petit. The number 6·6 at once strikes one as being remarkably near to the celebrated 6·4 of Dulong and Petit, and Prof. Carnelley draws the conclusion that there must be a connection between the two. This assumption appears to be supported by the following interesting facts. If we assume c to represent the atomic heat, then atomic weight = atomic heat $\times (m + \sqrt{v})$ = atomic weight $\times$ specific heat $\times (m + \sqrt{v})$; or specific heat $= \dfrac{1}{m + \sqrt{v}}$. On calculating the specific heats of the elements from this equation, they are found to agree remarkably well with the experimental values, except in those cases in which the observed specific heat is known to be abnormal. Again, Bettone has shown that the hardness of the elements is inversely proportional to their specific volumes. If this be so, hardness $= \dfrac{\text{specific gravity}}{6{\cdot}6(m + \sqrt{v})}$; and, on calculating the hardness from this formula, the numbers are again found to agree very closely with the hardness experimentally determined by Bettone. That the periodic law may therefore be approximately expressed by a formula of the type $A = c(m + \sqrt{v})$ appears very probable, and that the number 6·6 is a very close approximation to the value of c appears also to be established. Moreover, the fact that m in the even series represents a whole number, while in the odd series it represents a whole number and a half, corresponds to the well-known difference in chemical properties between the members of these series; and the assumption that the common difference between the first three values of m is only $2\frac{1}{2}$, while between all the rest it is $3\frac{1}{2}$, is borne out by Mendeleeff's statement that the elements of the lithium and sodium rows are more or less exceptional in their nature, and not strictly comparable with the subsequent series.

THE additions to the Zoological Society's Gardens during the past week include two Brown Capuchins (*Cebus fatuellus* ♂ ♂) from Paraguay, presented by Mr. E. Malateste; a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Miss Alice Booth; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. C. Harris; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Quarter-Master Serjeant Mathison, W.I.R.; a Silver Pheasant (*Euplocamus nycthemerus* ♂) from China, presented by Mr. W. R Rootes; a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from Rorke's Drift, South Africa, a Bonnet Monkey (*Macacus sinicus* ♀) from India, deposited.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on January 30 = 6h. 40m. 20s.

Name.	Mag	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 1425	—	—	6 26 31	+10 14
(2) DM. + 17° 1479 ...	6	Yellowish-red.	6 56 1	+17 53
(3) ε Canis Minoris ...	5	Yellowish-white.	7 19 6	+ 9 30
(4) γ Geminorum ...	2	Bluish-white.	6 31 24	+16 30
(5) 78 Schj.	6	Reddish-yellow.	6 28 59	+38 31
(6) R Leonis	Var.	Very red.	9 41 39	+11 56

Remarks.

(1) This nebula is described by Sir John Herschel as "pretty large, cometic, much brighter nucleus south following." The remarks relating to the nebula G.C. 1185 (see p. 257) apply equally in this case, the spectrum not having been recorded. Next in importance to observations of the general character of the spectrum will be observations of differences between the spectrum of the nucleus and that of the "tail." It seems hardly likely that the same spectrum will be given by the dense and sparse portions of the nebula.

(2) This star has a fine spectrum of the Group II. type. Dunér states that bands 2–8 inclusive are visible, and possibly also band 9, all the bands being very wide and dark. The point chiefly requiring attention in a spectrum of this character is the presence or absence of the compound fluting of carbon which extends from about wave-length 468 to 474, it having been suggested that band 9 is simply a contrast band due to the presence of this fluting. The mean wave-length given by Dunér for the edge of band 9 is 476·0, and if the suggestion referred to be of any value, this ought to be coincident with the less refrangible edge of the carbon group. This can only be satisfactorily settled by direct comparisons of the spectrum of the star with that of carbon, obtained in the usual way from a Bunsen or spirit-lamp flame.

(3) Vogel classes this with stars of the solar type. The usual differential observations are required.

(4) A star of Group IV. (Gothard). The usual observations are required (see p. 285).

(5) This is a star of Group VI., Dunér stating that the bands 2–9 are visible. Band 6 is a little weaker than the other carbon flutings. It seems probable that some of the brighter stars of the group will give metallic line absorptions, seeing that they are most probably formed by the cooling of stars like the sun, in which there are only traces of carbon absorption, whilst the line absorption is strongly marked. If the *b* group be present, it will most likely produce an apparent displacement of the carbon fluting to a slightly less refrangible position, its absorption being added to that of carbon. This can readily be determined by comparison with the spirit-lamp flame. Other lines may also appear, but *b* is mentioned as being amongst the more prominent solar lines.

(6) Mr. Espin found bright lines in the spectrum of this variable, when near its maximum in 1889. The star will again be at a maximum on January 30, and observers will therefore have an opportunity of making a more detailed examination of the spectrum. The general spectrum is of the Group II. type. Particular attention should be given to the bright carbon flutings, both at maximum and for some time after, as it seems probable that an increase of carbon radiation will accompany the appearance of the bright lines of hydrogen. The star ranges from about magnitude 6 at maximum to 9·5 at minimum, and the period is 313 days.

A. FOWLER.

THE TOTAL ECLIPSE OF JANUARY 1, 1889.—With a summary of the observations of this eclipse, Prof. Holden has come to the conclusion that coronal forms vary periodically, those of 1867, 1878, and 1889 being of the same form; that the outer corona, terminated in branching forms, suggests the presence of streams of meteorites near the sun, whilst the extension of the corona along and very near the plane of the ecliptic would show that such streams must have long been integral parts of the solar system. The photographs taken just before second and after third contact prove the corona to be, without doubt, a solar appendage. Spectroscopic observations indicate that the true atmosphere of the sun may be comparatively shallow, it being conclusively shown that the length of a coronal line is not always an indication of the depth of the gaseous coronal atmosphere of the sun at that point.—*Observatory*, January 1890.

THE ORBITS OF THE COMPANIONS OF BROOKS' COMET (1889 V., July 6.—The four companions which accompanied this comet were notified as B, C, D, and E, respectively, by Prof. Barnard, of the Lick Observatory (*Astr. Nach.*, 2919), the principal portion being called A. Prof. Bredichin has computed, as far as possible, the orbits of the companions (*Astr. Nach.*, 2949). Taking the elements given by Mr. Chandler for the principal mass A, the following elements have been found for C and E; all are reduced to mean equinox 1889·0:—

Elements of A's Orbit.

$$
\begin{aligned}
T &= 1889 \text{ October } 2{\cdot}1112 \\
\omega &= 344^\circ\ 29'\ 20''{\cdot}6 \\
\Omega &= 17\ \ 52\ \ 19{\cdot}0 \\
\iota &= 6\ \ 5\ \ 6{\cdot}9 \\
\phi &= 28\ \ 2\ \ 11{\cdot}6 \\
\log a &= 0{\cdot}565011 \\
\text{Period} &= 7{\cdot}0390 \text{ years.}
\end{aligned}
$$

Elements of C's Orbit.

$$
\begin{aligned}
T &= 1889 \text{ October } 1{\cdot}3369 \\
\omega &= 344^\circ\ 11'\ 47''{\cdot}1 \\
\Omega &= 17\ \ 15\ \ 24{\cdot}5 \\
\iota &= 6\ \ 5\ \ 6{\cdot}2 \\
\phi &= 28\ \ 2\ \ 13{\cdot}2 \\
\log a &= 0{\cdot}505059 \\
\text{Period} &= 7{\cdot}0402 \text{ years.}
\end{aligned}
$$

Elements of E's Orbit.

$$
\begin{aligned}
T &= 1889 \text{ October } 8{\cdot}7356 \\
\omega &= 347^\circ\ 30'\ 18''{\cdot}9 \\
\Omega &= 17\ \ 52\ \ 24{\cdot}5 \\
\iota &= 6\ \ 5\ \ 6{\cdot}2 \\
\phi &= 28\ \ 10\ \ 10{\cdot}5 \\
\log a &= 0{\cdot}564834 \\
\text{Period} &= 7{\cdot}0348 \text{ years.}
\end{aligned}
$$

The orbit of the mass B is situated between the orbits of A and C, and the orbit of D between those of C and E. From the inclination and position of the node it is evident that the division of the comet was effected in the plane of A's orbit, and the elements of C and E indicate almost the same point for the separation of the comet into these masses. It may be, therefore, that the separation was due to the action of Jupiter.

GREENWICH OBSERVATORY.—The Astronomer-Royal has issued the Greenwich Observations for 1887. An additional feature is the ten-year catalogue of 4059 stars, deduced from observations extending from 1877 to 1886, and reduced to the epoch 1880. The work, therefore, appears more bulky than ever.

THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF METEORITES AS THROWING LIGHT UPON THEIR PAST HISTORY.

IN several articles which appeared in NATURE last year I used the term meteorite as a generic one, to include all meteoritic masses, whether they consist of the tiniest specks which give rise to the instantaneous appearance of a shooting-star in the highest reaches of our air, or of the largest masses which have so far been found after their descent to the earth's surface.

I must now confine it to those masses which have reached the earth's surface, whether large or small, and I have first to refer to the various suggestions which have been made as to their origin.

The members of the Academy of Sciences of Paris were the last to acknowledge their extra-terrestrial origin, and that long after the writings and reasonings of Chladni, to which reference has been made.

Laplace ascribed them to lunar volcanoes,[1] by others it was imagined that they came from our own volcanoes; there were those, also, who held that they came from the sun; while, again, others thought they were fragments of a broken planet.

The theory of the volcanic origin of meteorites, whether lunar or terrestrial, does not satisfactorily explain the orbital motions around the sun, for, if this were their real origin, the meteorites would travel round the earth. Neither does it explain the relations which exist between comets and meteorites, for no one supposes that comets are effects of volcanic action. Further, fragments thus ejected from the earth's surface would be consumed in the journey by the same process which is afterwards to render them visible to us as shooting-stars.

With regard to the theory of the solar origin of meteorites, it is difficult to understand how solid bodies can come from the sun after passing through an immense thickness of the intensely heated solar atmosphere. Then, again, particles shot out from the sun would not travel in an orbit, as the meteorites do, but would simply move outwards in a straight line, and then fall back.

That the meteorites are fragments of a broken planet is supported by a considerable number of facts, but the main difficulty

[1] "Les Météorites," Meunier, p. 112.

is to establish the connection between comets and meteorites, as even the supporters of the theory do not claim that the comets are parts of a broken planet. Then, again, it is only an assumption that such a planet ever existed, and it is difficult to understand how a broken planet should so far disobey the law of gravity as to divide itself into small scattered fragments.

The real parentage of those meteorites which fall on our earth is, therefore, probably cometic, for the association of comets, meteorites, and shooting-stars can no longer be denied, and it is an observed fact that comets do break up.

The discovery of Schiaparelli (1866), and his view that the head of a comet was the largest meteorite in a swarm, of course, put these origins of some meteorites, at all events, out of the question.

Reichenbach (1858) did not consider that the head of a comet was a large meteorite, but a swarm of small ones, and the large meteorites he considered to be built up in some way out of the smaller ones brought into our system by comets. If this view be subsequently confirmed, since we now know that, as suggested by Schiaparelli, comets are nebulous shreds, brought into our system by solar or planetary attraction, it follows that in the nebulæ also we may be only dealing with excessively small masses.

If meteorites, in the restricted sense of the term above referred to, do not exist sporadically in external space, they must be manufactured in our system, and two tests should be open to us: (1) no meteorites should reach us from outer space; and (2) they should bear traces of the process by which they have been built up from cometary materials.

If we can establish this, then we imagine a gradual progression in the size of meteoritic masses from regions where they are so small that luminous collisions are all but impossible, to those regions nearest to a cooling sun, like our own, where there has been the richest supply of cometary material, furnished at successive perihelion passages for the longest time.

With regard to (1), we have the facts that it is only very rarely meteorites fall in displays of shooting-stars, and that when the earth has passed near a comet no increase in the average number of meteorites has been noticed.

The most important piece of evidence on this point, however, has been recently furnished by Prof. Newton, who, from a complete discussion of the data extant from all known falls, has come to the conclusion that all the meteorites now in our collections have come from a single ring of bodies circulating round the sun.

We next come to (2). The most important point to consider here, in the first place, is the very special structure of meteorites.

Thumb Markings.

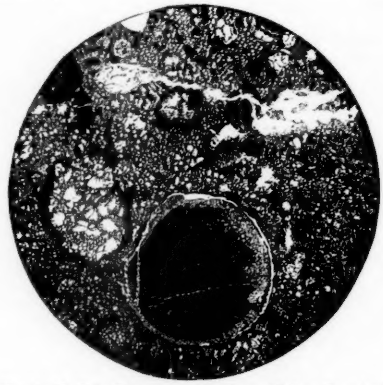
Regarding the origin of the remarkable pittings of the surfaces of aërolites and aërosiderites, an opinion was lately expressed and advocated by Daubrée,[1] that in their flight through the air they undergo erosion and excavation by joint effects of combustion and fusion, assisted mainly by air vortices attacking most violently certain portions of their surface. An important paper on this subject by Prof. Maskelyne was published immediately afterwards in the *Philosophical Magazine* (of August 1876). It is true that pittings identical in appearance with those of meteorites are found on the surfaces of certain large grains of powder blown unconsumed from the mouths of the large modern rifled ordnance (excellent specimens of this kind received from Prof. Abel and Major Noble having been shown by Prof. Maskelyne to M. Daubrée in the summer of 1875); but two important grounds for exception, in regard to this explanation, are pointed out by Prof. Maskelyne, which must not be overlooked. The closest examination of the molten glaze with which, like other parts of these surfaces, the pittings or depressions of meteorites are coated over, shows no indications of vorticose action of the air, although stream-lines of the glaze from front to rear are of frequent and conspicuous occurrence. The process of atmospheric combination, or combustion, is also rare, if not entirely absent, during the period of most intense operation of the heat, as is shown by particles of metallic iron which are occasionally found embedded in the glaze, and even by cases where the highly oxidizable mineral oldhamite (calcium sulphide), occurring in spherules in the Bustee meteorite, is glazed over equally with the augite without offering any signs of combustion or of the production of cavities where they are exposed.

[1] *Comptes rendus*, April 24, 1876. See "Report on Observations of Luminous Meteors for the year 1875–76," p. 167.

Chondritic Structure.

We have spherules of iron, like small shot of different sizes, in the stones.

These spherules, or chondroi, as they are sometimes called, vary very considerably in size; some reach the size of a cherry, while others are so small that they can only be seen by the aid of a microscope.



Chondroi in Soko-Banya meteorite (magnified 10 diameters)

Chondroi in Mocs meteorite (magnified 10 diameters)

By examining sections of chondritic stony meteorites we find that they consist sometimes almost entirely of spherules. The Parnellee aërolite affords us a very good instance of this, the most varied groups of spherules being seen collected together in one section. These spherules are sometimes encased in small shells of nickeliferous iron, or sometimes in addition with a kind of pyrites, a sulphide of iron termed troilite (FeS), peculiar to meteorites.

Some chondroi have round depressions which point to plasticity during contact, as if the spherules which form the splintered fragments had acquired their form during the act of rubbing. Others, again, have projections of a rounded form, or an almost pointed end.[1]

Our terrestrial rocks contain no structure identical with that chondritic structure so peculiar to meteorites, and the characters of the spherules are found to be quite different from those in either perlite or obsidian.

Tschermak[2] directs attention to the peculiarities observed in several chondritic meteorites. The first is the occurrence of a crust over the surface of the bronzite spherules, possessing fibrous structure. This crust is thin, and is distinguished from the inclosed material by its paler colour; it has the same fibrous

[1] Flight, "History of Meteorites," p. 207.
[2] Quoted from "Report of Observations of Luminous Meteors during the Year 1877–78," p. 107.

structure, doubly refractive power, and, in fact, is optically orientated like the inclosed silicate. It appears to be produced by some agent acting from without, perhaps heat in conjunction with a reducing gas. The agent has not caused friction, but a slight modification of the texture of the surface.

Indications afforded by Crystalline Structure.

The mixed minerals of meteorites have been subjected to microscopic examination by Sorby[1] and Rose,[2] and both have found that the crystals differ in some essential particulars from those of volcanic rocks.

Sorby long since showed that when crystals are formed by deposition from water or from a mass of melted rock, they often catch up portions of this water or melted stone which can be seen as cavities containing fluid or glass. Crystalline minerals formed by purely aqueous or by purely igneous processes can thus be distinguished. One of the most common of the minerals in meteorites is olivine, and when met with in volcanic lavas this mineral usually contains only a few and small glass-cavities in comparison with those seen in such minerals as augite. The crystals in meteorites are generally only small, and thus the difficulty of the question is considerably increased. However, by careful examination with high magnifying power, Sorby found well-marked glass-cavities, with perfectly fixed bubbles, the inclosed glass being sometimes of brown colour and having deposited crystals. On the contrary he was never able to detect any trace of fluid-cavities, with moving bubbles, and therefore he holds it very probable, if not absolutely certain, that the crystalline minerals in meteorites were chiefly formed by an igneous process, like that which has produced lava, and analogous volcanic rocks.

Passing from the structure of the individual crystals to that of the aggregate, Sorby points out that in some cases we have a structure in every respect analogous to that of erupted lavas, though even then there are very curious differences in detail.

The results of the observations of the kinds of crystallization noted in meteorites by many eminent authorities go to show that it took place hastily. Thus Brezina, after making a complete study of the Vienna collection, comes to the conclusion that the structural features of meteorites are the result of a hasty crystallization.

Again, it is the opinion of several high authorities that the crystallization did not necessarily take place under conditions of high temperature.

M. Daubrée's opinion is thus expressed :—[3]

"It is extremely remarkable that, in spite of their great tendency to a perfectly distinct crystallization, the silicate combinations which make up the meteorites are there only in the condition of very small crystals, all jumbled together as if they had not passed through fusion. If we may look about us for something analogous, we should say that, instead of calling to mind the long needles of ice which liquid water forms as it freezes, the fine-grained texture of meteorites resembles rather that of hoar frost, and that of snow, which is due, as is known, to the immediate passage of the atmospheric vapour of water into the solid state."

This possibility of the absence of high temperature is thus further insisted upon by Prof. Newton :—[4]

"The meteorites resemble the lavas and slags of the earth. These are formed in the absence of water, and with a limited supply of oxygen, and heat is present in the process. But is heat necessary? Some crystallizations do take place in the cold; some are direct changes from gaseous to solid forms. We cannot in the laboratory reproduce all the conditions of crystallization in the cold of space. We cannot easily determine whether the mere absence of oxygen will not account fully for the slag-like character of the meteoric minerals. Wherever crystallization can take place at all, if there is present silicon and magnesium and iron and nickel, with a limited supply of oxygen, their silicates ought to be expected in abundance, and the iron and nickel in their metallic forms. Except for the heat, the process should be analogous to that of the reduction of iron in the Bessemer cupola, when the limited supply of oxygen combines with the carbon, and leaves the iron free."

Should this view be subsequently confirmed, all early ideas touching the formation of meteorites will require to be modified. Thus, in 1855, Prof. Lawrence Smith stated: "They have all been subject to a more or less prolonged igneous action corresponding to that of terrestrial volcanoes." Haidinger, in 1861, not only declared for high temperature, but for high pressure.

[1] Proc. R.S., January 1864. [2] Berlin Acad. Trans.
[3] Quoted by Newton, NATURE, vol. xxxiv. p. 535. [4] NATURE, *loc. cit.*

Obviously, these views, which were based more upon the analogues of some of the meteorites with volcanic basic rocks than upon the actual character of the crystallization, suggested the formation of large masses; and the ideas that comets were solid bodies and that meteorites were fragments of comets or planets were both based upon these views,[1] and the higher the temperature required and the slower the crystallization, the larger in imagination did these possible birthplaces of the meteorites become.

If neither much time nor heat be required to produce the crystallization observed, then, with Prof. Newton, we can suppose "a mass containing silicon, magnesium, iron, nickel, a limited supply of oxygen, and small quantities of other elements, all in their primordial or nebulous state (whatever that may be), segregated somewhere in the cold of space. As the materials consolidate and crystallize, the oxygen is appropriated by the silicon and magnesium, and the iron and nickel are deposited in metallic form. Possibly the heat developed may, before it is radiated into space, modify and transform the substance. The final result is a rocky mass (or possibly several adjacent masses) which sooner or later is, no doubt, cooled down throughout to the temperature of space."

We shall see subsequently that there are many known causes in operation which will provide us with just such a mixed mass of vapours as Prof. Newton requires, and it is at once obvious that, not only is the generic separation into iron and stones thus accounted for, but the special form of crystallization observed in stones and the special chondritic structure observed both in irons and stones would all arise from the same cause.

Evidences of Heating and Action of Violent Forces at Different Times.

The peculiarities in the mineralogical structure of the meteorites are probably in part due to the successive heatings and coolings to which they were subjected with each approach of the comet to the sun, and partly, perhaps, to the heat of combination of oxygen and silicon. They were most probably formed in a limited supply of oxygen, so that the elements possessing greatest affinity for that element were the first to form compounds, leaving iron and nickel in the metallic or uncombined state.

Some meteoric stones from examination seem to have been heated to a high temperature right through their mass. Such cases as Orvinio, Chantonnay, Juvenas, and Weston show signs that fragments are cemented together with a material of the same substance as themselves. Again we have indications of chemical changes, the chondroi in some stones being found to be surrounded by spherical and concentric aggregations of minute particles of nickel, due, as is supposed, to the reducing action of hydrogen at a high temperature.

Some meteorites are merely breccias, consisting of fragments, the *débris* of pre-existing meteorites, or of the original mass tremendously shattered, and subsequently cemented together.

In this connection Sorby writes :—

"It would therefore appear that, after the material of the meteorites was melted, a considerable portion was broken up into small fragments, subsequently collected together, and more or less consolidated by mechanical and chemical actions, amongst which must be classed a segregation of iron, either in the metallic state or in combination with other substances. Apparently this breaking up occurred in some cases when the melted matter had become crystalline, but in others the forms of the particles lead me to conclude that it was broken up into detached globules whilst still melted (Mezö-Madaras, Parnellee). This seems to have been the origin of some of the round grains met with in meteorites; for they occasionally still contain a considerable amount of glass, and the crystals which have been formed in it are arranged in groups, radiating from one or more points on the external surface, in such a manner as to indicate that they were developed after the fragments had acquired their present spheroidal shape (Aussun, &c.). In this they differ most characteristically from the general type of concretionary globules found in terrestrial rocks, in which they radiate from the centre; the only case that I know at all analogous being that of certain Oolitic grains in the Kelloways rock at Scarborough, which have undergone a secondary crystallization."[2]

Mr. Sorby remarks: "A most careful study of their microscopical structure leads me to conclude that their con-

[1] See Newton, NATURE, vol. xxxiv. p. 534.
[2] "Microscopical Structure of Meteorites," Proc. R.S., June 16, 1864.

stituents were originally at such a high temperature that they were in a state of vapour, like that in which many now occur in the atmosphere of the sun, as proved by the black lines in the solar spectrum." We may, in fact, look upon them as being to planets what the minute drops of water in the clouds are to an ocean. He has shown that possibly, after the condensation of the vapour, they collected into larger masses, which have been subsequently changed by metamorphic action, broken up by mutual impact, and again collected and solidified, the meteoric irons possibly being those portions of the metallic constituents which were separated from the rest by fusion when the metamorphosis was carried to the extreme point.

In this manner the subsequent heating, or any number of subsequent heatings, are explained.

Iron Meteorites not fused in falling.[1]

A question of no slight interest in regard to the changes which meteoric irons undergo during their passage through the atmosphere is whether their surface becomes fused. From his study of the Charlotte meteorite, Dr. Smith is inclined to answer it in the negative. The fact of the delicate reticulated surface having been preserved is a proof that the heat, instead of having been raised to a high temperature, has quickly been conducted away into the mass of metal. Had fusion of the superficial layer taken place, the meteorite would have been coated with molten oxide.

Veins.

Now and again we come across meteorites which have veins, like terrestrial rock-veins, running right through them. Prof. Maskelyne's description of them is as follows :—[2]

"Just as in a mine one may meet with a fissure that, once dividing the 'country,' but subsequently filled by rocky matter, cuts across the course of a mineral vein which itself was originally formed in a similar way ; and just as such a cross fissure, thus intersecting with the original metalliferous vein, often gives us evidence of a heave, *i.e.* that one side of the new fissure has slid upwards or downwards along the other, so an exactly similar thing is met with in meteorites, and is admirably seen in the microscopic sections of them."

Faults and throws are both represented in meteorites. In that of Aumières there is a throw of several centimetres indicated, and faults intersect. These faults are accompanied by heat due to the friction of the surfaces, and in the case of gray stony meteorites the faults are black like the crust.[3] (The black veins are physically connected with the crust, and are supposed to have the same origin, the melted material having filled up the fissures.)

On examining such meteorites as Château-Renard, Pultusk, and Alessandria, it is found that some of the spherules even are broken in half and the halves separated from each other by a vein of meteoric iron or troilite, and in some cases by a black fused substance, like the crust of a meteorite.

The Presence of Sulphides.

The presence of sulphides, which must have been formed when both water and free oxygen were absent, shows a distinctly non-terrestrial condition, as, indeed, does also the presence of small particles of iron. On this point Dr. Flight remarks :[4] "If the conditions necessary for the formation of pure calcium sulphide be borne in mind, the evidence imported into this inquiry by the Bustee aërolite seems further to point to the presence of a reducing agent during the formation of its constituent materials."

Sorby's General Conclusions.

We have before referred to Sorby's microscopical examination of meteorites. In 1865 he stated the general conclusions he had arrived at as follows. It will be seen how remarkable the agreement is between him and Reichenbach.

"As shown in my paper in the Proceedings of the Royal Society (xiii. 333), there is good proof of the material of meteorites having been to some extent fused, and in the state of minute detached particles. I had also met with facts which seemed to show that some portions had condensed from a state of vapour ; and expected that it would be requisite to adopt a modified nebular hypothesis, but hesitated until I had obtained more satisfactory evidence. The character of the constituent particles of meteorites and their general microscopical structure differ so much from what is seen in terrestrial volcanic rocks, that it appears to me extremely improbable that they were ever portions of the moon, or of a planet, which differed from a large meteorite in having been the seat of a more or less modified volcanic action. A most careful study of their microscopical structure leads me to conclude that their constituents were originally at such a high temperature that they were in a state of vapour, like that in which many now occur in the atmosphere of the sun, as proved by the black lines in the solar spectrum. On cooling, this vapour condensed into a sort of cometary cloud, formed of small crystals and minute drops of melted stony matter, which afterwards became more or less devitrified and crystalline. This cloud was in a state of great commotion, and the particles moving with great velocity were often broken by collision. After collecting together to form larger masses, heat, generated by mutual impact, or that existing in other parts of space through which they moved, gave rise to a variable amount of metamorphism. In some few cases, when the whole mass was fused, all evidence of a previous history has been obliterated ; and on solidification a structure has been produced quite similar to that of terrestrial volcanic rocks. Such metamorphosed or fused masses were sometimes more or less completely broken up by violent collision, and the fragments again collected together and solidified. Whilst these changes were taking place, various metallic compounds of iron were so introduced as to indicate that they still existed in free space in the state of vapour, and condensed amongst the previously formed particles of the meteorites. At all events the relative amount of the metallic constituents appears to have increased with the lapse of time, and they often crystallized under conditions differing entirely from those which occurred when mixed metallic and stony materials were metamorphosed, or solidified from a state of igneous fusion in such small masses that the force of gravitation was too weak to separate the constituents, although they differ so much in specific gravity. (Report of British Association, 1864.) Possibly, however, some meteoric irons have been produced in this manner by the occurrence of such a separation. The hydro carbons with which some few meteorites are impregnated may have condensed from a state of vapour at a relatively late period.

"I therefore conclude provisionally that meteorites are records of the existence in planetary space of physical conditions more or less similar to those now confined to the immediate neighbourhood of the sun, at a period indefinitely more remote than that of the occurrence of any of the facts revealed to us by the study of geology—at a period which might in fact be called *pre-terrestrial.*"

Are Meteorites merely Modern Phenomena ?

It has often been a subject of remark that in spite of the very considerable number of undoubted meteorites now in various collections, we scarcely have traces of any which suggest like falls in any of the geological periods preceding the present one.

The iron found by Prof. Nordenskiöld at Ovifac, Western Greenland, was at first thought to be meteoric iron of Miocene age, but after an analysis of the basalt or lava rocks of Assuk, Disco Island, a part of the same basaltic range in Greenland, only 100 miles from the spot where Prof. Nordenskiöld's discovery was made, it was held by most authorities to be no other than the metallic nickel-iron which is, though extremely rarely, a native product in some terrestrial rocks. Other explorers besides Prof. Nordenskiöld have brought back specimens of this iron, and Dr. Lawrence Smith has stated, not only that the nickel-iron of Ovifac is without doubt of terrestrial origin, but that the specimens brought back by the other explorers resembles the Ovifac and each other remarkably, while they differ from meteoric iron by the large proportion of combined carbon in their composition.

Again, in NATURE, vol. xxxv. p. 36, we have a description of another meteorite supposed to be a fossil one, found in a block of Tertiary coal. It was said to belong to the group of meteoric irons, and was taken from a block of coal about to be used in a manufactory of Lower Austria. On its examination by various specialists, different origins were assigned to it. Some believed it to be meteoric, others an artificial production, and others again thought it was a meteorite modified by the hand of man. After a careful examination Dr. Gurlt came to the conclusion that there was no ground for believing in the intervention of human agency. The mass was almost a cube, two opposite faces being rounded, and the four others being made smaller by these roundings. A deep incision ran all through the cube. The

[1] Quoted from the "Report on Observations of Luminous Meteors during the year 1874–75," p. 247.
[2] NATURE, vol. xii. p. 505.
[3] Flight, *loc. cit.*, p. 111.
[4] *Loc. cit.*, p. 119.

faces and the incision bore such characteristic traces of meteoric iron as to show that the mass was not the work of man. A layer of oxide formed a thin covering of the iron; it was 67 mm. high, 67 mm. broad, and 47 mm. at its thickest part; it was found to be about as hard as steel, and besides carbon it contained a small percentage of nickel. It resembled the meteoric masses of St. Catherine in Brazil, and Braunau in Bohemia, found in 1847.

The evidence, however, is so strong that what we really obtain now at the earth's surface forms but a very small portion of the meteorites which enter the upper air, that it would not be probable that in former ages of the earth's history, when the atmosphere was denser than it is now, anything whatever would be left by the time the surface was reached.

J. NORMAN LOCKYER.

SCIENTIFIC SERIALS.

American Journal of Science, January.—Measurement of the Peruvian arc, by E. D. Preston. In this paper, which was read before the American Association for the Advancement of Science at Toronto, August 1889, the author reviews the whole question of the relative lengths of the earth's axes, dealing in detail with Bouguer's expedition to Peru in 1735, and arguing that the amplitude of his Peruvian arc may be in error by many seconds. Hence he contends that the geodetic science of to-day demands the remeasurement of this arc.—Neutralization of induction, by John Trowbridge and Samuel Sheldon. A system of neutralization for inductive disturbances is here described, which might be adopted where it is impossible to employ entire metallic circuits in which the earth plays no part.—Divergent evolution and the Darwinian theory, by Rev. John T. Gulick. The author discusses Darwin's apparently contradictory views on the causes of natural selection on the one hand, and on the other on the causes of diversity of natural selection. He concludes that, though Darwin has not recognized segregation as a necessary condition of divergence of species, he has indicated one process (geographical or local separation under different environments) by which segregation is produced in nature, adding, however, that this is not the only cause of segregation and consequent divergence.—The Devonian system of North and South Devonshire, by H. S. Williams. During a recent visit to England the author studied this system both on the spot and in the geological collections in London and elsewhere. He dwells especially, (1) on the close resemblance of the English Devonian species to those of the New York Devonian, though mostly passing under different names, and (2) on the character of the North and South Devonian rocks, which in appearance, composition, and order are as different as two distinct systems well can be.—The zinciferous clays of South-West Missouri, and a theory as to the growth of the calamine of that section, by W. H. Seamon. Full analyses are given of the so-called "tallow" and "joint" clays occurring associated and sometimes intermixed in every calamine digging in South-West Missouri. These analyses show a large percentage, often from 50 to 56, of zinc oxide, and it is inferred that at one time all the massive calamine probably existed in "tallow clays" precipitated from solutions.—On the spectrum of ζ Ursæ Majoris, by Edward C. Pickering.—Origin of normal faults, by T. Mellard Reade. Some critical remarks are offered on Prof. Le Conte's recent explanation of the origin of normal faults, which is not new, and presents many insuperable difficulties.—Papers were submitted by J. Dawson Hawkins, on a specimen of minium from Leadville; by William P. Blake, on some minerals from Arizona; by F. A. Genth, on a new occurrence of corundum in Patrick County, Virginia; by Alfred C. Lane, on the estimation of the optical angle of observations in parallel light; by L. G. Eakins, on a new stone meteorite from Texas; by Edward S. Dana, on the barium sulphate from Perkin's Mill, Templeton, Province of Quebec; and by O. C. Marsh, on some new Dinosaurian reptiles recently discovered in Wyoming, Colorado, and Dakota.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 9.—"A Milk Dentition in *Orycteropus*." By Oldfield Thomas, Natural History Museum. Communicated by Dr. A. Günther, F.R.S.

Of the few Mammalia in which no trace of a milk dentition has been found, *Orycteropus*, the Aard-Vark, has always occupied a prominent place, owing partly to the peculiar structure of its prominent teeth, and partly to its very doubtful systematic position.

An opportunity has now fallen in my way of proving that it has after all two sets of teeth, those of the first, or milk set, being rudimentary, and probably quite functionless, but nevertheless so far developed as to be all completely calcified, and to be for the most part readily distinguishable by form and position from those of the second or permanent set.

Among the collections in the Natural History Museum there are two very young females of *Orycteropus afer* in spirit, presented by Sir Richard Owen, and it is in these that the milk teeth now to be described occur. The larger of the two measures 18 inches in total length, and the smaller 14 inches.

Each of these specimens has a complete, although rudimentary, set of milk teeth, extending the whole length of the maxillary bones above, and along a rather shorter portion of the mandible below. None, however, are observable in the premaxillæ, or in the corresponding anterior part of the mandibles. The teeth are all quite minute, and it is doubtful whether they would ever have cut the gum.

In the upper jaw there appear to be normally no less than seven milk teeth. Of these the most posterior is by far the largest, has a rudimentary crown, and two distinct roots, anterior and posterior. The others are simple and styliform.

In the lower jaw there are four milk teeth only, of which, again, the most posterior is more or less molariform.

As to the structure of the milk teeth, a horizontal section of the last upper one, ground down in the dry state, presents numerous large openings which are obviously the sockets into which pulp-papillæ have extended, so that the milk teeth show a commencement of the remarkable histological structure characteristic of the permanent teeth.

But important as a knowledge of the presence of a milk dentition in *Orycteropus* is, it does not at present render any easier the difficult questions as to the phylogeny and systematic position of that animal. Although called an Edendate, it has always been recognized as possessing many characters exceedingly different from those of the typical American members of the order.[1] It has in fact been placed with them rather on account of the inconvenience of forming a special order for its reception than because of its real relationship to them. Now, as they are either altogether toothless or else homodont and monophyodont (apart from the remarkable exception of *Tatusia*), it seems more than ever incorrect to unite with them the solitary member of the *Tubulidentata*, toothed, heterodont, and diphyodont, and differing from them in addition by its placentation, the anatomy of its reproductive organs, the minute structure of its teeth, and the general characters of its skeleton.

But if *Orycteropus* is not genetically a near relation of the Edendates, we are wholly in the dark as to what other Mammals it is allied to, and I think it would be premature to hazard a guess on the subject. Whether even it has any special connection with *Manis* is a point about which there is the greatest doubt, and, unfortunately, we are as yet absolutely without any palæontological knowledge of the extinct allies of either. *Macrotherium* even, usually supposed from the structure of its phalangeal bones to be related to *Manis*, has lately proved (see Osborn, *American Naturalist*, vol. xxii. p. 728, 1882) to have the teeth and vertebræ of a Perissodactyle Ungulate, and one could not dare to suggest that the ancestors of *Manis* or *Orycteropus* were to be sought in that direction. Lastly, as the numerous fossil American Edentates do not show the slightest tendency to an approximation towards the Old World forms, we are furnished with an additional reason for insisting on the radical distinctness of the latter, whose phylogeny must therefore remain for the present one of the many unsolved zoological problems.

Physical Society, January 17.—Prof. W. G. Adams, Vice-President, in the chair.—Owing to the unavoidable absence of Mr. F. B. Hawes, his paper on a carbon deposit in a Blake telephone transmitter was postponed.—Dr. S. P. Thompson made a communication on electric splashes, and illustrated his subject by beautiful experiments on the production of Lichtenberg's figures. The author has recently investigated these phenomena as modified by varying the conditions under which

[1] On this subject see especially Flower, "On the Mutual Affinities of the Animals composing the Order Edentata," Zool. Soc. Proc., 1882, p. 358 *et seqq.*

the figures are obtained, and has arrived at the following conclusions: (1) the nature of the dielectric plate does not change the character of the figures produced, and (2) the nature of the powders used seems to have no material effect on their shape. In the course of his experiments he has found a mixture of sublimed sulphur and lycopodium to give better figures than the red lead and sulphur usually employed, and also that a large and highly polished knob is advantageous, particularly when the Leyden jar is charged negatively. Sometimes when obtaining negative figures, nebulous patches occur, and these were attributed to the so-called electric winds sent off from roughnesses on the knob when not sufficiently well polished. If instead of bringing the knob in contact with the plate, it is only brought near to it, then a peculiar figure closely resembling a "splash" results. A positive splash consists of short lines radiating from the point of approach, whilst a negative splash is made up of more or less rounded spots which become elongated in a radial direction as their distance from the centre of the splash increases. Negative splashes are, however, much more difficult to produce than positive ones. When viewed in the dark, the discharge producing the splash is seen to consist of a bundle of small sparks which branch outwards on approaching the plate. In conclusion the author remarked that roughnesses on a conductor produced more electric winds when the conductor is charged negatively than when positively charged, and invited the opinions of members as to the causes of the differences observed between positive and negative electricity. Prof. Rücker said he had recently obtained figures produced by discharges on photographic plates. Generally he observed that negative discharges produce roundish patches, whilst positive ones give more filamentary figures. On passing a spark across a glass plate covered with lampblack, its trace was found to have a black core at one end, whilst the other was quite clear. He also made remarks on the distinctive character of the positive and negative discharges in partial *vacuo*, and considered investigations as to the causes of such differences to be of great importance. Prof. Adams thought any attempt to discover the causes of such differences as those noted in the paper was to be commended, for the well-known fact that it is more difficult to insulate a negative charge than a positive one has long needed an explanation.—A paper on galvanometers, by Prof. W. E. Ayrton, F.R.S., T. Mather, and W. E. Sumpner, was read by Prof. Ayrton. In fitting up the Physical Laboratories of the Central Institution of the City and Guilds of London Institute, the authors have had occasion to obtain galvanometers of various types and patterns, some of which have been made to special designs, and specimens of instruments embodying recent improvements were exhibited at the meeting. The question as to whether fairly sensitive galvanometers should be astatic or non-astatic was answered in favour of the former system, from the fact of its being less affected by external magnetic disturbances, and the greater ease with which great sensibility may be obtained. The usual method of placing the mirror inside the coil was shown to be undesirable, and in the newer forms of instruments Mudford's improvement of placing the mirror outside the coils has been adopted; the space near the axis of the coil being nearly filled with wire. It was also shown that if wire be wound in a certain approximately spheroidal space near the magnets, then these convolutions will tend to oppose the more distant portions of the coil; however, by winding the two parts in opposite directions they conspire to deflect the magnet. Details as to methods of supporting the coils were then discussed, and the importance of fitting them in boxes mounted on hinges or otherwise, so as to be readily removable, was pointed out. A galvanometer devised for teaching purposes, and provided with variable damping arrangements was described, in which the damping is effected by enclosing the mirror in a glass cell whose sides can be caused to approach or recede by turning a milled head outside the instrument. This arrangement enables the damping to be varied between wide limits, and its effect on the swing produced by a given discharge can be determined. The instrument is also serviceable both as an ordinary damped galvanometer, or as a fairly ballistic one. In measuring quantities of electricity by the first swing of a galvanometer needle, a correction has usually to be introduced for damping; this correcting factor is simple enough when the damping is small, but becomes more complicated as the damping increases, and to facilitate the calculations a table of values of the factor for various values of λ (the logarithmic decrement) has been calculated. From this it appears that, for values of λ less than 0·5, the value of the factor is very nearly $(1 + \frac{1}{2}\lambda)$, the correction usually employed. Improvements in methods of insulating the coils and terminals of galvanometers required for insulation tests were next described, the principle of which may be gathered from Figs. 107 and 108 in Prof. Ayrton's "Practical Electricity." A special form of instrument for high insulation work was exhibited, in which the copper resistance of the coils is nearly 400,000 ohms, and the shortest path along which surface leakage can take place from the coils to the base of the instrument is between 30 and 40 inches of ebonite artificially dried by sulphuric acid. This is attained by supporting the coils from two corrugated ebonite rods which depend from a brass ring carried on the top of three corrugated pillars fixed to the base plate. The instrument was constructed to drawing and specification by Messrs. Nalder Brothers, but the method of supporting the coils was suggested by Messrs. Eidsforth and Mudford. With reference to the proportionality of deflection to current in reflecting galvanometers, it was pointed out that ordinary instruments may differ as much as 2 per cent. within the limits of the scale, hence showing the necessity for calibration when any approach to accuracy is desired. Galvanometers of the D'Arsonval type sometimes differ from proportionality quite as much as the one above referred to, but by fitting such instruments with curved pole pieces, and allowing the coil to hang freely from the top suspension, a proportionality true to less than 0·15 per cent. has been attained over a scale about 30 inches long. Coming to the question of sensitiveness, the importance of keeping the wire as close as possible to the magnets was brought prominently forward, as well as the necessity of reducing the "figures of merit" of various instruments to the same standard, in comparing their sensibilities. The standard adopted as most convenient and closely approximating to practical usage is arrived at by supposing the distance of the mirror from the scale to be equal to 2000 scale divisions, and the sensibilities for current and quantity are given as *scale divisions per micro-ampere*, and *scale divisions per micro-coulomb* respectively. The period of oscillation is also taken into account. A table showing the resistances, sensibilities, coefficients of self-induction and volumes of the coils of various instruments, together with the relations existing between them, accompanies the paper, and from this it appears that in the best astatic double coil instruments, of from 10,000 to 30,000 ohms resistance, the number of scale divisions per micro-ampere may reach 400 times the resistance to the $\frac{2}{5}$th power (400 $R^{\frac{2}{5}}$) when the period is 10 seconds. In obtaining data of various instruments the authors have consulted, amongst others, Prof. Threlfall's paper on the measurement of high specific resistances, in the *Phil. Mag.* for December 1889, and noticed two serious errors. The first of these makes an instrument constructed according to Messrs. Gray's pattern nine times less sensitive than it actually was, whilst the sensibility of a form recommended in the paper is given seventeen times too great. On account of the lateness of the hour, the discussion was adjourned till February 6, before which time it is hoped that a fairly full abstract will appear in the technical papers.

Geological Society, January 8.—W. T. Blanford, F.R.S., President, in the chair.—The following communications were read:—On some British Jurassic fish-remains referable to the genera *Eurycormus* and *Hypsocormus*, by A. Smith Woodward. Hitherto our knowledge of the Upper Jurassic fish fauna has been mainly derived from specimens found in fine lithographic stones, where the various elements are in a state of extreme compression. Within the last few years remains of similar fish have been discovered in the Oxford and Kimeridge Clays of England, and these are of value for precise determination of certain skeletal features in the genera to which they belong. The author described *Eurycormus grandis* from the Kimeridge Clay of Ely, a large species which makes known for the first time the form and proportions of several of the head-bones in this genus. A technical description of all the bones the characters of which are distinguishable was given, and the author concluded that there is considerable similarity between the head of *Eurycormus* and the recent Ganoid *Amia*, even to minute points of detail. He further described *Hypsocormus tenuirostris* and *H. Leedsii* from the Oxford Clay of the neighbourhood of Peterborough, the osteology of this genus not having as yet been elucidated. Portions of the jaws have been discovered, affording valuable information as to the form and dentition of the principal elements. These jaws are not precisely paralleled by any other Jurassic genus, though they possess a resemblance to *Pachycormus*, as also to the Upper Cretaceous genus, *Protosphyræna*. The President remarked that *Amia* is a

freshwater genus, and inquired whether the fossil fish was freshwater or marine. Mr. E. T. Newton remarked upon the great interest and importance of the paper. The author, in reply to the President's question, said that the old Ganoids were marine, and it was only in more recent times that they had become restricted to fresh water.—On the Pebidian volcanic series of St. David's, by Prof. C. Lloyd Morgan. After a brief sketch of the principal theories that have been propounded, the author concluded that our knowledge of this series has not yet reached "a satisfactory position of stable equilibrium." His own communication was divided into three sections. *The Relation of Pebidian to Cambrian:* There are four localities where the junction is described—Caerbwdy Valley, St. Non's Bay, Ogof Golchfa, and Ramsey Sound. The stratigraphy of the second of these was given with much detail, and illustrated. The author concluded that here, together with clear signs of local or contemporaneous erosion, the general parallelism of the strike of Pebidian and Cambrian is most marked. There is no evidence of any bending round of the conglomerate against the strike of the Pebidians. The stratigraphical evidence in each of the localities having been considered, together with the evidence offered by the materials of the Cambrian conglomerate and local interstratification with the volcanic beds (the interdigitation at Carnarwig being well marked), he concluded that there was no great break between the conglomerate and the underlying Pebidians. The uppermost Pebidian already foreshadowed the sedimentary conditions of the Harlech strata, and the change emphasized by the conglomerate was one that followed volcanic conditions after no great lapse of time. Hence the relation of the Pebidian to the Cambrian is that of a volcanic series, for the most part submarine, to succeeding sedimentary strata—these strata being introduced by a conglomerate formed in the main of foreign pebbles borne onward by a current which swept the surface of, and eroded channels in the volcanic tuffs and other deposits. He was disposed to retain the name Pebidian as a volcanic series in the base of the Cambrian system. *The Pebidian Succession:* With the exception of some cinder-beds, which appear to be subaërial, the whole series was accumulated under water. There is no justification for making separate subdivisions; the series consists of alternating beds of tuff of varying colour and basicity, the prevailing tints being dark green, red-grey, and light sea-green. In the upper beds there is an increasing amount of sedimentary material, and more rounded pebbles are found. Basic lava-flows occur, for the most part, in the upper beds. Detailed work, laid down on the 6-inch Ordnance map, appears to establish a series of three folds—a northern anticline, a central syncline, and a southern anticline—folded over to form an isocline, with reversed dips to the south-east. The axis of folding is roughly parallel to the axis of St. David's promontory. The total thickness is from 1200 to 1500 feet. The author devoted a considerable number of pages to further details concerning this series of deposits. He failed to find the alleged Cambrian overlap. "The probabilities are that it is by step-faults brtween Rhoson and Porth Sele, and not by overlap, that the displacement of the conglomerate has there been effected." Also at Ogof Gôch it does not rest upon the quartz-felsite breccia and sheets (group C, of Dr. Hicks), but is faulted against them. A section was devoted to the felsitic dykes, and it was suggested that they may be volcanic dykes of Cambrian age. *The Relation of the Pebidian to the Dimetian:* The author has not been able to satisfy himself of the existence of the Arvonian as a separate and distinct system. He notes the junction of Pebidian and Dimetian in Porthlisky Bay and the Allen Valley at Porth Clais, at neither of which places are there satisfactory evidences of intrusion. At Ogof Llesugn the intrusive character of the Dimetian was strongly impressed upon him. He criticized the mapping of Dr. Hicks, and pointed out the difficulties which present themselves in the way of mapping the Dimetian ridge as pre-Cambrian. He pointed out that not a single pebble of Dimetian rock, such as those now lying on the beach in Porthlisky Bay, is to be found in the conglomerate. He concluded that the Dimetian is intrusive in the southern limb of the isocline, and that there are no Archæan rocks *in situ*. After the reading of this paper there was a discussion, in which the President, Dr. Hicks, Prof. Blake, Prof. Hughes, and Mr. Williams took part.

SYDNEY.

Royal Society of New South Wales, November 6, 1889.—Monthly meeting.—Prof. Liversidge, F.R.S., President, in the chair.—The Chairman announced the death of the Rev. J. E. Tenison-Woods, who had been an honorary member of the Society since 1875.—The following papers were read:—Aids to the sanitation of unsewered districts, poudrette factories, by Dr. J. Ashburton Thompson.—Notes on Goulburn lime, by E. C. Manfred.—Notes on some minerals, &c., by John C. H. Mingaye.

December 4.—Monthly Meeting.—Prof. Liversidge, F.R.S., President, in the chair.—The following papers were read:—Well and river waters of New South Wales, by W. A. Dixon.—The Australian aborigines, by Rev. John Mathew.

PARIS.

Academy of Sciences, January 20.—M. Hermite in the chair.—On the various states of the carbon graphites, and on the chemical derivatives corresponding to them, by MM. Berthelot and P. Petit. The graphites, when oxidized by the wet process at a low temperature, form ternary compounds, one of whose terms has been discovered by Brodie. But M. Berthelot has since shown that there exist several chemically distinct graphites, each forming a particular graphitic oxide, which yields a corresponding hydrographitic and pyrographitic oxide, and which may be recovered with all their primitive properties. These various graphites and the series of corresponding compounds have been studied, first by their composition and behaviour, and in a second memoir by the measurement of the heats of combustion and formation.—Remarks on the formation of the nitrates in plants, by M. Berthelot. The author points out that the facts established by Haeckel and Lundström, taken in connection with his own observations, tend to show an affinity between the microbes present in the soil and those developed in the plant. This applies to the microbes which fix the nitrogen of vegetable humus and the leguminous plants, as well as to those which similarly form the nitrates in amaranthus, sterculia, the coffee shrub and vegetable humus.—Note on a fundamental point of the theory of polyhedrons, by M. de Jonquières. The paper deals with Euler's famous formula $S + H = A + 2$, and shows that it is applicable, and intended by Euler to be applicable, to all polyhedrons without exception, and not restricted to any particular class, as supposed by Legendre, Cauchy, and others.—Ephemerides for the search of the periodical comet of d'Arrest on its return in 1890, by M. Gustave Leveau. Having previously obtained the elements for the years 1870, 1877, and 1883, by allowing for the disturbing influence of Jupiter, Saturn, and Mars, M. Leveau here supplies those for 1890 (February 25, mean Paris time) by studying the disturbing effects produced by Jupiter in the interval between 1883 and 1890.—Observations of Swift's comet made at the Observatory of Nice with the 0·38 m. equatorial, by M. D. Eginitis.—On the solar statistics for the year 1889, by M. Rud. Wolf. From the solar observations made at Zurich and the magnetic observations recorded at Milan, the author has constructed a table of monthly means showing that both the relative numbers and the magnetic variations have continued to diminish during 1890. But he thinks that the retrograde movement will soon cease, and that we probably entered the minimum period towards the end of last year.—On the theory of the figure of the planets, by M. M. Hamy. An attempt is here made to realize theoretically the conditions of a system answering to M. Poincaré's remarkable theorem published in the *Comptes rendus* for June 1888.—On the integration of an equation with partial derivatives, by M. Zaremba. The paper deals with an equation of the form

$$\frac{d^2x}{dxdy} + \phi_1(x+y)\left(\frac{dz}{dx} + \frac{dz}{dy}\right) + \phi_2(x+y)z = 0,$$

where ϕ_1 and ϕ_2 are two functions whatsoever of $x + y$, and shows that the determination of the general integration may be reduced to the integration of an ordinary linear differential equation of the second order, and to quadratures.—On the variation of the resistance of bismuth in the magnetic field, by M. A. Leduc. The author here continues his studies of the electric resistance of bismuth as affected by varying temperature.—Calculation of the compressibility of nitrogen up to 3000 atmospheres, by M. Ch. Antoine. The results of fresh calculations are here summed up in a table resuming all the data relative to the pressure of nitrogen up to a pressure of 3000 atmospheres.—On the combinations of the metals of the alkalies with ammonia, by M. H. W. Bakhuis Roozeboom. An explanation is offered of the curious phenomena mentioned by M. Joannis in his recent

communication (*Comptes rendus*, cix. p. 900) on the combinations of potassium and sodium with ammonia.—On the absorption of the ultra-violet rays by some organic substances belonging to the fatty series, by MM. J. L. Soret and Alb. A. Rilliet. These studies, which to a large extent confirm the conclusions of Messrs. Hartley and Huntington (Philosophical Transactions of the Royal Society, 1879), show in a general way that the measurement of the absorption of the ultra-violet rays constitutes a delicate means of estimating the purity of organic substances.—On the refracting powers of double salts in solution, by M. E. Doumer. These researches have been carried on by the same method which enabled the author to determine the refracting powers of simple salts. The results, which are here tabulated, show that the molecular refracting power of a double salt is equal to the sum of the molecular refracting powers of the constituent simple salts; and in general, the molecular refracting power of any salt, simple or double, is proportional to the number of valences of the metallic part of the salt.—Papers were read by M. Ph. A. Guye, on the molecular constitution of bodies at the critical point; by M. Raoul Varet, on the reactions between the salts of copper and the metallic cyanides; by MM. C. Chabrié and L. Lapicque, on the physiological action of selenious acid; and by M. L. de Launay, on the geology of the island of Lesbos. M. de Launay considers the volcanic eruptions of this island as comparatively recent, possibly not older than the Pliocene epoch, and doubtless contemporary with the disturbances resulting in the creation of the Ægean Sea in a region previously forming a vast marshy plain with shallow lakes.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—Investigations into the Effects of Training Walls in an Estuary like the Mersey: L. F. Vernon Harcourt.—On Outlying Nerve-Cells in the Mammalian Spinal Cord: C. S. Sherrington.—On the Germination of the Seed of the Castor-oil Plant (Ricinus communis): Prof. J. R. Green.
ROYAL INSTITUTION, at 3.—Sculpture in Relation to the Age: Edwin Roscoe Mullins.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—Smokeless Explosives: Sir Frederick Abel, C.B., F.R.S.

SATURDAY, FEBRUARY 1.

ESSEX FIELD CLUB, at 7.—Annual General Meeting.—Migration of Birds: E. A. Fitch, President.
ROYAL INSTITUTION, at 3.—The Natural History of the Horse, and of its Extinct and Existing Allies: Prof. Flower, C.B., F.R.S.

SUNDAY, FEBRUARY 2.

SUNDAY LECTURE SOCIETY, at 4.—The Health of the Mind; and Mental Contagions: Dr. B. W. Richardson, F.R.S.

MONDAY, FEBRUARY 3.

SOCIETY OF ARTS, at 8.—The Electromagnet: Dr. Silvanus P. Thompson.
SOCIETY OF CHEMICAL INDUSTRY, at 8.—On the Properties and Applications of Metallic Compounds of the Phenols: A. H. Allen and W. W. Staveley.
ARISTOTELIAN SOCIETY, at 8.—The Conception of Sovereignty: D. G. Ritchie.
ROYAL INSTITUTION, at 5.—General Monthly Meeting.

TUESDAY, FEBRUARY 4.

ZOOLOGICAL SOCIETY, at 4.—On the Morphology of a Reptilian Bird (Opisthocomus cristatus): W. K. Parker, F.R.S.—Observations on Wolves, Jackals, Dogs, and Foxes: A. D. Bartlett.—A Synopsis of the Genera of the Family Soricidæ: G. E. Dobson, F.R.S.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Bars at the Mouths of Tidal Estuaries: W. H. Wheeler.
ROYAL INSTITUTION, at 3.—The Post-Darwinian Period: Prof. G. J. Romanes, F.R.S.

WEDNESDAY, FEBRUARY 5.

GEOLOGICAL SOCIETY, at 8.—The Variolitic Rocks of Mount Genèvre: G. A. J. Cole and J. W. Gregory.—The Propylites of the Western Isles of Scotland and their Relation to the Andesites and Diorites of the same District: Prof. J. W. Judd, F.R.S.
ENTOMOLOGICAL SOCIETY, at 7.—On the Peculiarities of the Terminal Segment in some Male Hemiptera: Dr. Sharp.—The Lepidoptera of Burmah: Colonel Chas. Swinhoe.—On the Phylogenetic Significance of the Wing-Markings in certain Genera of Nymphalidæ: Dr. F. A. Dixey.
SOCIETY OF ARTS, at 8.—High-Speed Knitting and Weaving without Weft: Arthur Paget.
UNIVERSITY COLLEGE CHEMICAL AND PHYSICAL SOCIETY, at 4.30.—The Life and Work of Faraday: S. B. Schryver.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.
LINNEAN SOCIETY, at 8.—On the Stamens and Setæ of Scirpeæ: C. B. Clarke, F.R.S.—On the Flora of Patagonia: John Ball, F.R.S.
CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Oxides of Nitrogen: Prof. Ramsay, F.R.S.—Studies on the Constitution of Tri-Derivatives of Naphthalene: Dr. Armstrong and W. P. Wynne.—On the Action of Chromium Oxychloride on Nitrobenzole: G. G. Henderson and J. Morrow Campbell.
ROYAL INSTITUTION, at 3.—Sculpture in Relation to the Age: Edwin Roscoe Mullins.

FRIDAY, FEBRUARY 7.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—On Galvanometers: Prof. W. E. Ayrton, F.R.S., T. Mather, and W. E. Sumpner.—On a Carbon Deposit in a Blake Telephone Transmitter: F. B. Hawes.
GEOLOGISTS' ASSOCIATION, at 7.30.—Annual General Meeting.—Notes on the Nature of the Geological Record: The President.
SOCIETY OF ARTS, at 5.—The Utility of Forests and the Study of Forestry: Dr. Schlich.
INSTITUTION OF CIVIL ENGINEERS, at 7.30.—Reclamation of Land on the River Tees: Colin P. Fowler.
ROYAL INSTITUTION, at 9.—The London Stage in Elizabeth's Reign: Henry B. Wheatley.

SATURDAY, FEBRUARY 8.

ROYAL BOTANIC SOCIETY, at 3.45.
ROYAL INSTITUTION, at 3.—The Natural History of the Horse, and of its Extinct and Existing Allies: Prof. Flower, C.B., F.R.S.

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